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AN INTERNATIONAL JOURNAL REPORTING THE PRACTICAL APPLICATION OF OUR NEWER KNOWLEDGE OF NUTRITION

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Treatment of OBESITY *with Calorically* UNRESTRICTED DIETS

By A. W. PENNINGTON, M.D.

IT IS well known that weight reduction requires a limitation of the caloric intake to a level below that of the caloric expenditure. This limitation is usually effected by conscious restraint of the appetite but there appears to be reason for believing that it can also be accomplished by physiological forces which, being brought to bear upon the appetite, regulate it so that weight is lost without the necessity for enforcing caloric restriction. In normal individuals, the appetite appears to be limited by regulatory mechanisms; and though these are disturbed in the obese, they continue to operate at the higher level of body weight. It seems reasonable, therefore, to expect that, if the cause of the disturbance can be removed, these still-intact mechanisms should adjust the caloric intake to output at a normal weight level.[1]

Evidence has been presented for a metabolic block in the oxidative pathway of pyruvic acid as a factor which, by inducing excessive fat storage, disturbs the balance between caloric intake and output; and restriction of carbohydrate has been suggested as a treatment in a calorically unrestricted diet composed, essentially, of protein and fat. Restriction of carbohydrate, it is believed, by removing much of the source of pyruvic acid, alleviates the inhibiting influence of this substance on the oxidation of fat, with the result that the energy needs of the tissues, being more fully supplied from the body's own reserve stores, dictate a correspondingly smaller intake of food.[1]

The strategic advantage of such a plan of treatment has been pointed out by Dole *et al.*[2] There appears, however, to be an even greater advantage to this method of treatment, in contrast to general restriction of the whole dietary pattern; for, when carbohydrate, alone, is restricted, there is no decline in the basal caloric expenditure.[1] When, however, the total caloric intake is restricted, a decline in basal caloric expenditure is to be expected.

BASAL CALORIC EXPENDITURE OF THE OBESE ON LOW CALORIE DIETS

This subject has been reviewed by Rynearson and Gastineau,[3] who refer to the work of Brown and Ohlson[4] and of Strang and Evans[5] as showing a decrease in basal caloric expenditure of the obese on low calorie diets, and to the work of Evans and Strang,[6] Moller,[7] Mulier and Topper,[8] and Rony[9] as showing no such decrease. Rony's conclusions were based on the experiments of Evans and Strang[6] and of Keeton and Bone.[10] Rynearson observes that the question of the fall of the basal metabolic rate in the reduction of weight of obese persons is of some importance; but he finds the reports contradictory, and he feels that insufficient studies have been made to permit the formation of any definite conclusion.

Brown and Ohlson's studies[4] showed an average decline of 17 per cent in basal calories among eight young women of college age; and

From Medical Division, E. I. du Pont de Nemours and Co., Wilmington, Del.

Strang and Evans, in their five cases, showed a decline of 14 per cent, which was greater than the decline in either the weight or surface area. The reference to the work of the latter investigators as showing, also, that no decline occurs, stems from their introduction of a special formula for calculating metabolic rates from the ideal, rather than from the actual weight—a method based on the assumption that fatty tissue is metabolically inert and that, therefore, its weight should not be taken into account when metabolic calculations are made. The discovery that fatty tissue is metabolically active, however,[11] seems to rule out the validity of metabolic calculations based on ideal weights, a method of calculation which has been used to make the metabolism of the obese appear hypernormal and its decline on low calorie diets advantageous.[3]

Examination of the basic data of those who reported no decline in metabolism reveals that, actually, there *was* a decline which was not considered significant. The one case studied by Moller[7] showed a decline of 12.5 per cent in basal metabolic rate (B.M.R.) (calculated from the graph). Mulier[8] found a decline of only 3.8 per cent in the B.M.R. of 25 children, but pointed out that the pelidisi of Pirquet* is a better standard in this age group than is the usual surface area rule. Calculations from the graphs of the eight cases studied by Keeton and Bone[10] show that there was an average decline of 12.2 per cent in the B.M.R. They did not consider this significant because the rates did not fall below the arbitrary limit of normal, customarily used in interpreting clinical tests of the metabolism. It seems, however, that in physiological experiments such as this it is more appropriate to take note of the actual changes in the significant variables. The basic data of the various investigators seem to give overwhelming evidence that, in the obese adult at least, there is a fall in metabolic rate attendant on the use of low calorie diets.

* According to Pirquet, the cube of the sitting height in centimeters is approximately the weight in grams of a normal person.

Significance of the Decline in Basal Energy Expenditure

It was found that obese individuals, who had lost weight after treatment by low calorie diets, maintained a constant weight on a food intake considerably lower than that of other people of similar age and dimensions.[4] This would seem to indicate that, between the two groups, there exists a metabolic difference which would require that the formerly obese person must subsist on a subcaloric intake of food the rest of his life if he chooses to control his weight by this means. Continuance of subcaloric diets after weight reduction has, in fact, become a standard recommendation.[3] It would seem that the situation with formerly obese persons is very similar to that of normal individuals who have accustomed themselves to a caloric intake below their requirement. In both there would seem to have occurred what Lusk referred to as a "specific reduction in metabolism coincident with undernutrition."[12]

The question of greatest significance in connection with the use of low calorie diets is whether it is true, as is generally believed, that the reserve stores of fat are drawn upon in an amount sufficient to meet the metabolic needs of the organism. It might be reasoned that a fall in basal metabolic rate means only that the requirement of the tissues for energy has declined, and that their metabolic needs are fulfilled in any case. Another interpretation, however, could be that there is an optimal metabolic rate for each individual, and that a decline below this rate indicates that less than an optimal amount of energy is being made available for the metabolic work of the tissues. This interpretation would be in accord with Benedict's view that the basal metabolism is "a very good index of the general state or level of vital activities."[13] The basal metabolism would appear to be an index of caloric nutrition at the cellular level. As customarily interpreted, however, basal metabolism tests are rarely of great value except in the diagnosis and treatment of diseases of the thyroid gland;[14] and it may very well be that in ordinary clinical practice the range of error

is too wide for uses which require greater precision.

The answer to the question whether the decline in metabolic rate of the obese on low calorie diets merely reflects a lessened requirement of the tissues, or, on the other hand, whether it signifies that the tissue requirements are not being fulfilled, would seem to necessitate an inquiry into some of the most fundamental matters in metabolic theory. Metabolic theory, in its broadest scope, attempts to answer the question: what causes the body to oxidize the amount of nutrient materials that it does? Current thought on the matter has been largely colored by Rubner's concept of a rigidly fixed caloric expenditure, determined by the requirement; this in turn is determined by the surface area of the body. This concept was opposed vigorously by Rubner's teacher, Voit, who insisted that, *while the tissues have a certain maximal capacity for metabolizing foodstuffs, the amount they actually metabolize is influenced by the quantity and the quality of the nutrient materials brought to them by the blood.*[12] "The requirement for energy," Voit said, "cannot possibly be the cause of metabolism any more than the requirement for gold will put it into one's pocket." Voit's concept of the metabolism would seem to find support in studies which show that the utilization of glucose,[15] fatty acids,[16] and ketones[17] by the tissues is influenced by the concentrations of these substances in the blood. The decline in metabolism of the obese during weight reduction by low calorie diets, therefore, might reasonably be taken to indicate that the reserve stores of body fat are not being mobilized rapidly enough to meet the metabolic needs of the tissues.

Stimulation of Fat Utilization during Weight Reduction

It would seem desirable in the treatment of the obese to direct measures primarily toward an *increased* mobilization and utilization of fat, instead of relying upon the dubious ability of caloric restriction to draw adequately upon the adipose deposits. If fat mobilization can be stimulated to a sufficient degree, and inhibition of fat oxidation can be reduced, it should be possible for the tissues to utilize this nutrient material to the maximum extent of which they are capable. There would then be no question of a shortage of calories for performing the metabolic work of the tissues, and no decline in metabolic rate would be expected. This, it seems, is the situation produced when obesity is treated by calorically unrestricted diets in which carbohydrate, alone, is limited.

A diet consisting essentially of protein and fat is ketogenic. Ketogenesis, it appears, is the normal mechanism by which the organism is enabled to utilize fat in much larger quantities than it otherwise could.[18] Ketonemia, furthermore, is followed by increased mobilization of fatty acids from the adipose tissues.[19] Consequently, the blood concentration of both ketones and fatty acids becomes increased, causing the tissues to oxidize them in larger amounts.[16,17]

Ketogenesis, therefore, would seem to be the key to the possibility of weight reduction on calorically unrestricted diets; and this would have special applicability to the obese, in whom the ketogenic response to fat feeding is greater than it is in the lean.[20] A greater than ordinary quota of the energy requirements would be urged upon the tissues by the increased mobilization of the body's fat deposits, and the appetite would decline to a corresponding extent. Animal experiments in which nutrient materials are introduced into the drinking water indicate a very precise adjustment in the voluntary caloric intake[21] and it seems that the effect would be the same whether the nutrients were added to the metabolic pool from without or from the body's own reserve stores. Mobilization of an increased quantity of utilizable fat, then, would be the limiting factor on the appetite, effecting the disproportion between caloric intake and expenditure which is necessary for weight reduction.

When such a plan of treatment is used, the actual caloric intake would vary according to the needs of each individual from day to day. This appears to be a great advantage, for daily variations in physical activities and other factors affect the energy requirements;

and weight loss would proceed in any case, for under these circumstances the adipose tissues, first, furnish a considerable quota of the nutriment required by the organism, leaving the appetite to make up the remainder. The large caloric requirements of the obese for maintaining constant weight have often been emphasized. Evans found that they range up to 4500 calories a day.[3] There is, therefore, nothing remarkable in the observation that, when this method of treating obesity is used, some obese individuals must, of necessity, lose weight on an intake of 3000 calories or more per day.

Practical Application of This Method of Treatment

In the practical use of this method a minimum of 8 ounces of meat has been recommended for each of the three meals of the day; and to emphasize that fat, as well as lean, is to be eaten, one part of fat to three parts of lean meat has been suggested as the proper proportion. This is the general proportion adopted by choice when an exclusive meat diet has been followed.[22]

Carbohydrate has been allowed in an amount calculated not to interfere with ketogenesis. Peters found that 100 Gm. of carbohydrate would reduce ketogenesis,[18] but the amount seems to vary in different individuals.[23] The very low calorie diets of Strang and Evans, containing only 40 Gm. of carbohydrate, were ketogenic,[24] and these diets showed a very favorable protein-sparing action. In most of the patients on a calorically unrestricted diet, 60 Gm. of carbohydrate per day have been allowed, although in a few cases a more drastic reduction has seemed necessary. Since most patients, though they are familiar with calories, are not familiar with the quantity of carbohydrate, in grams, in various foods, it has seemed helpful to provide a list of a few foods containing an average of about 20 Gm. of carbohydrate in an ordinary serving.

Liberal amounts of water have been allowed. Salt has been restricted, both for the value of this in the treatment of certain diseases often associated with obesity, and also because there is at least one report which suggests that the metabolism may be increased by this means.[25] Salt, as is well known, often causes fluid retention, and this may exist in a subclinical degree more often than is realized. The clinical impression is gained that, with some individuals at least, salt interferes with weight loss on calorically unrestricted diets to an extent not explainable by the weight of the water which may be retained.

A general hygienic regimen has been advised, including regular rest, without oversleeping. A half-hour walk, or the equivalent exercise, before breakfast, also has been recommended. The reason for this is that, while 60 per cent of the energy needs of the body are supplied by fat after the usual overnight fast, the proportion can be increased by exercise in the post-absorptive state.[18] The entire success of treatment by calorically unrestricted diets, it seems, depends upon effectively stimulating the use of fat by the organism.

Since the obese patient must have a concise, readily understandable guide to go by, the following sheet of instructions, embodying the matters set forth above, has been prepared and has proved satisfactory during the past four years. Like most sheets of dietary instructions, its form is didactic; otherwise the patient is likely to become indecisive on many points. Although some may find reason to question certain details, it has seemed best to present it in its entirety, in the form in which it has been effectively used. The essential principle on which a calorically unrestricted diet appears to work—that of sufficiently stimulating the oxidation of fat—is quite different from that of low calorie diets; and one of the chief tasks in applying it is to establish the new orientation.

Reasoning associated with the use of low calorie diets has been so ingrained that matters applicable to such diets can quite inadvertently be carried over into the use of a calorically unrestricted diet, impairing its effectiveness. Such, it seems, was the fate of the calorically unrestricted diet based on a concept of obesity as a defect of carbohydrate metabolism, devised by the physician, W.

Harvey, from reflections upon the lectures of Claude Bernard, which he attended in 1856.[26] Harvey's diet, which attempted to avoid sweet and starchy foods, specifically, while allowing meat in *ad libitum* amounts, met with widespread success[27] and had a permanent influence on the treatment of obesity. However, since certain details of the diet could not find a rationale in the prevailing physiology of Liebig, the diet underwent a succession of modifications, retaining only those features which conformed to current theory. Finally, as the "modified Banting" diets, it lost its identity among the many low calorie diets of the nineteenth century.

The sheet of instructions for the calorically unrestricted diet which has been in use during the past four years[28] is as follows:

A Diet for Obesity

With this diet you follow a definite routine which is as important as the diet itself. Have a regular hour for going to bed. Set your alarm clock for eight hours sleep, never a minute more than that, and allow time for a thirty-minute walk before breakfast. It is not necessary to walk fast, but it is necessary to walk the full thirty minutes regularly.

Breakfast, lunch, and dinner are all the same type. You eat three big meals a day and lose seven pounds of excess weight a month.

First course of each meal: One-half pound or more of fresh meat with the fat. This part of the diet is unlimited. You can eat as much as you want. The proper proportion is three parts of lean to one part fat. Most of the meat you buy is not fat enough, so get extra beef kidney fat, slice and fry it to make up the proper proportion. Good meats are roast beef, steak, roast lamb, lamb chops, stewed beef, fresh pork, and pork chops. Hamburger is all right if you grind it yourself just before it is cooked. Season the meat with black pepper before it is cooked or use paprika, celery seed, lemon, chopped parsley, or celery tops, or use other flavoring which does not contain salt.

Do not use the least particle of salt. Do not use foods which contain salt, such as soup, bacon, smoked ham, canned chicken, or fish containing salt, frankfurters, bologna, canned or spiced meat, or salted butter.

Second course of each meal: This part of the diet is strictly limited. At each meal you have a choice of an ordinary portion of any one of the following: white potatoes, sweet potatoes, boiled rice, half grapefruit, grapes, slice of melon, a banana, a pear, raspberries or blueberries.

At the end of each meal have a cup of black coffee or tea without sugar. Do not use saccharine.

Be sure to drink six glasses of water every day before five o'clock. Your only other beverage is half a lemon in a glass of water if you desire it.

This diet contains *no* bread, flour, salt, sugar, alcohol, or anything else not mentioned.

Summary

Restriction of carbohydrate, alone, appears to make possible the treatment of obesity on a calorically unrestricted diet composed chiefly of protein and fat. The limiting factor on appetite, necessary to any treatment of obesity, appears to be provided by increased mobilization and utilization of fat, in conjunction with the homeostatic forces which normally regulate the appetite. Ketogensis appears to be a key factor in the increased utilization of fat. Treatment of obesity by this method appears to avoid the decline in the metabolism encountered in treatment by caloric restriction. Details of diet and regimen are given.

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Resumen

Tratamiento dietético de la obesidad sin restricción calórica

Restricción de los solos hidratos de carbono parece hacer posible el tratamiento de la obesidad con una dieta libre cuanto a las calorías y compuesta principalmente de proteína y grasas. El factor limitador del apetito que requiere cualquier tratamiento de la obesidad lo parece proveer la aumentada mobilización y utilización de las grasas, en conjunto con las fuerzas homeostáticas que normalmente arreglan el apetito. La ketogénesis parece ser un factor importante en la aumentada utilización de las grasas. El tratamiento de la obesidad por este método parece evitar el descenso del metabolismo que se encuentra en el tratamiento por restricción calórica. Detalles del régimen se presentan.

INFANT FEEDING

By HARRY BAKWIN, M.D.*

INFANT feeding has been greatly simplified during the past 25 years. Precise calculation of the caloric needs and of the percentage of the various dietary constituents, at one time regarded as essential in "scientific" infant feeding, has gone by the board. It has become evident that there is no more rationale for the daily balancing of the nutritional requirements of infants than for the daily balancing of profits and losses in a business.

Recent years have witnessed an increasing interest in the psychologic aspects of infant feeding. The types and amounts of food and the intervals between feedings are being reevaluated in the light of a clearer understanding of the principles underlying child development. The need for individualization is recognized, and the effort is made to adjust feeding to the needs of the infant and the temperament of the mother.

It would be a mistake however, to assume that the strictly nutritional aspects of infant feeding have been solved. Some of the obscurities in this field are illustrated by a comparison of the different responses of babies to feeding with human and cow's milk.

BREAST FEEDING

The composition of human and cow's milk is dissimilar, both qualitatively and quantitatively, in every known constituent.[1] The amount of protein in human milk is less than half that of cow's milk. The lactalbumen component is somewhat higher in cow's milk, the casein content is much lower. By electrophoretic analysis casein can be separated into two or possibly three fractions of different chemical composition. The amounts of these fractions are different in human and cow's milk. Cow's milk casein can be further differentiated from human milk by immunologic reactions and by *in vitro* digestion analysis.

The percentages of fat are about the same in the two milks but the fats differ in composition, human milk fat containing about 7 per cent linoleic acid, cow's milk little or none.

The salt content of cow's milk is much higher than that of human milk and the relation of the salts, notably calcium and phosphorus, is different. The milks are also unlike in their content of the B group of vitamins and in vitamin C. Since cow's milk is generally pasteurized, it contains only a small amount of ascorbic acid. It is of interest that neither milk, unless artificially reinforced, contains appreciable amounts of vitamin D or iron.

Perhaps more important than the dissimilarities in composition are the differences in the metabolic responses of infants receiving the two milks.[2] Though the percentages of ingested nitrogen, calcium, and phosphorus which are retained are smaller in infants receiving cow's milk than in those on human milk, the absolute amounts retained are greater. Consequently the body compositions of the two groups of babies are different, those who receive cow's milk having more nitrogen, calcium, and phosphorus in their make-up than the breast-fed. Nevertheless, tetany, a manifestation of hypocalcemia, is much more frequent in the cow's milk-fed infant; and rickets, in which calcium phosphate deposition in bone is interfered with, is apt to be more severe. The greater frequency of tetany in infants receiving cow's milk is probably related to its relatively high phosphate content. Many years ago Finkelstein[3] was able to show that the clinical manifestations of tetany in infants can be allayed by substituting human

From The Department of Pediatrics, College of Medicine, New York University-Bellevue Medical Center, New York, N. Y.

* Professor of Clinical Pediatrics, New York University-Bellevue Medical Center.

for cow's milk in the diet. Bakwin[4] has shown that phosphate feeding in newborns leads to a reduction in the serum calcium, and he suggests that artificial feeding is a factor in the pathogenesis of tetany in the newborn. Gardner and his co-workers[5] have confirmed and extended these observations.

Breast-fed infants are less prone to gastrointestinal disturbances and respiratory infections than are the artificially fed. It is not, however, to be assumed that immune bodies are transferred to the babies through the milk. In certain species, notably the ruminants, immune bodies reach the offspring through the colostrum, and newborn calves, deprived of colostrum, die of colon bacillus septicemia. The human infant receives its immunity from the mother before birth by way of the placenta.

Eczema is less frequent in breast- than in bottle-fed infants.

A difference also exists in the responses to ingested vitamin C. Infants on human milk maintain a "normal" level of ascorbic acid in the blood plasma when the mother takes the usual amounts in her diet. The baby on cow's milk requires very large amounts (approximately 75 to 100 mg., or the amount of ascorbic acid in 5 to 7 ounces of orange juice) to maintain a similar level. The difficulty in maintaining a normal blood level is probably related to the high protein content of cow's milk, the need for ascorbic acid rising as the protein intake increases.

Natelson, Kramer, and Sherman[6] have demonstrated a difference in the blood sugar responses to the two milks, the blood sugar rising to a higher level in infants receiving human milk than in those on raw or evaporated cow's milk formulas containing the same amount of lactose.

Artificially fed infants, then, are unlike the breast-fed in their chemical constitution, in their reaction to certain infections of the respiratory and intestinal tract, in their response to sunlight deficiency (tetany and rickets), in the greater frequency of eczema, generally regarded as an atopic disease in infants, and in their responses to ingested sugar and ascorbic acid. Involution of the uterus proceeds more rapidly in the mother when she suckles her baby.

Though claims as to the significance of breast-feeding for the emotional development of the child are, in general, exaggerated, it is reasonable to assume that the experience has some meaning for mother and child and that, in certain instances, it may be a significant factor in setting the pattern for future parent-child relations. Most mothers who nurse their babies derive therefrom a feeling of satisfaction and a sense of achievement not readily obtainable otherwise. In addition, the nearness of the infant and the physical contact during nursing help to establish an early intimacy between mother and child which becomes more and more meaningful to him as he grows older.

Pediatricians are agreed, in the main, that breast milk is the preferred food for infants. Though the available evidence, as outlined above, shows that there are definite differences in body make-up and physiologic response between breast-fed and artificially fed infants, it is not possible to assert that one group is superior to the other. Under the circumstances, one can but defer to nature and recommend the milk specially designed for humans.

Practical Considerations

It is unwise to urge a mother to nurse her baby unless she wants to. Such discussion is not only futile; it may induce feelings of guilt and it will certainly antagonize her against the physician who is overly insistent.

A mother who is doubtful as to whether or not she wants to nurse her baby may be told that breast-feeding is preferred by physicians because it is the natural way, that she and the baby will come to enjoy the experience, that, for a few months at any rate, she will not have to prepare formulas or sterilize bottles. She need not eat excessively nor drink large amounts of milk, she can smoke, drink alcoholic beverages, and exercise in moderation, and her figure will not suffer.

Success in breast-feeding depends to a large extent on how strongly the mother desires to nurse and on the attitude of her husband, the

obstetrician, the hospital personnel, and the pediatrician. Above all, the woman who is planning to nurse her baby needs encouragement and a certain amount of information. Even before the birth of the baby she should understand that the amount of milk which the baby will get during the first few days of life will be negligible and that the baby, physiologically, loses weight regardless of what sort of food he is given. The breasts during the first week or so will be engorged and the nipples difficult to grasp. Knowing this, the mother will be less apt to be discouraged by the baby's often fruitless efforts.

Beginning about six weeks before birth she may massage her breasts, nipples, and areolae daily with cocoa butter, lanolin, or cold cream.[7] When the nipples are flat or inverted she is shown how they may be drawn out several times a day to make them more prominent. At the same time, the correct way to manually express the breasts is demonstrated. The mother with small, flat breasts during pregnancy may be assured that this is no reason why she cannot nurse just as effectively as others. All these measures serve a useful purpose, if only in focussing parental interest on breast-feeding.

During the first two or three days of life, before the milk comes in and while the infant is losing weight, the mother needs reassurance that everything is proceeding normally. If she is living under "rooming-in" conditions where she has her baby close at hand, she may feed him when she thinks he is hungry. Under these circumstances, the baby will be awake and will probably suck vigorously, whereas, when he is put to the breast "on schedule," he may be apathetic or sleepy and he will consequently suck weakly or not at all, thereby discouraging the mother.

Factors in some hospitals which militate against breast-feeding are the antagonistic attitude of many nurses, who find that breast-feeding (especially a night feeding) interferes with their routine, the daily weighing of babies (which is unnecessary, indeed unwise, since it is a means of spreading infection), the routine use of sugar solutions to prevent dehydration fever, and the early resort to complementary feedings to promote weight gain. Supplying the baby with a bottle containing water or food blunts the appetite and consequently the intensity of sucking which is the best stimulus to the flow of milk.

In discussing breast-feeding one should avoid stressing its importance to such a degree that the mother will feel inadequate or guilty if she finds it impossible to nurse her baby.

Artificial Feeding

The large majority of infants will thrive on a formula consisting of two-thirds whole milk, one-third water, and sugar in the proportion of one ounce in 20 ounces of total volume. This formula may be started on the third day of life (earlier feeding is unnecessary and unphysiologic) and continued until three or four months of age, when the infant is transferred to whole milk. Evaporated milk (one part to two parts of water with added sugar) is widely used in the preparation of formulas and has the advantages that it is of good quality, constant composition, sterile, cheap, and readily obtainable almost anywhere. The cheapest sugar (sucrose) is as good as the most expensive.

The only added vitamins necessary during infancy are C and D. Ascorbic acid may be started at one month as orange juice in teaspoon doses diluted with an equal amount of water. The orange juice is given once a day and increased rapidly to 2 or 3 ounces. At two months the orange juice may be given undiluted. For infants who cannot tolerate orange juice a daily supplement of 50 mg. of synthetic ascorbic acid may be given instead. It is dropped into the milk just before feeding.

Of the available preparations of vitamin D we prefer percomorph oil since it is a natural oil. It may be started at about two weeks of age. Five drops once a day (about 1000 units of vitamin D) are ample during the first year. Additional amounts of vitamin D are ordinarily obtained in evaporated milk (about 400 units per 13-ounce can), in whole milk which is reinforced with the vitamin, and in other foods. Vitamin D supplements should not be given during the summer months (April

15 to September 15) except under special circumstances. (I see no use whatsoever in giving vitamin D to a private patient during the summer months. Given a dark-skinned child who is not taken outdoors, the situation would have to be handled individually.)

Self-Regulation

The wisdom of allowing the infant to eat when he likes, what he likes, and as much as he likes, has been widely debated. Advocates of this technique hold that it is reasonable to feed infants according to their demands rather than by standards based on averages, and that infants fed in this way seem better satisfied and cry less. Moreover, infants acquire a hunger rhythm as part of the development process and spontaneously put themselves on a schedule.

Self-regulation or self-demand relates to (1) the interval between feedings, (2) the amount of food, and (3) the type of food.

During the first two weeks of life hunger contractions are almost continuous and the feeding demands are irregular. Therefore, self-demand has little meaning at this age. A hunger rhythm appears at about two weeks of age.

The early cry is not specific. According to Sherman,[8] experts were unable to distinguish the hunger cry from crying for other reasons. Only at about one month is it possible for the mother to recognize the hunger cry (Gesell).

Mothers who feed their babies on self-demand find that their babies put themselves on a schedule, but that sometimes the daily rhythm begins at 8 a.m., on other days at 6 or 7 a.m., and so on. It is difficult to run an orderly household with a routine which changes unpredictably each day.

Experience has taught that the large majority of young babies will adjust to a 4-hour schedule starting at the same time each day and, since this suits well the convenience of most homes, it seems to be a wise procedure. However, this should not imply rigid adherence to a time schedule. It is well to keep in mind that a certain number of young babies will be unhappy with a 4-hour interval and one should, therefore, be prepared to make changes whenever they appear to be necessary.

Elimination of the night feeding, usually at 2 a.m., depends on the appearance of a long sleep period of about 8 hours. This ordinarily takes place at three to eight weeks. As with other developmental phenomena, the change does not appear abruptly. Over a period of some weeks there may be considerable shifting back and forth between the old and new routines until the new way becomes established. The evening feeding (10–11 p.m.) is omitted when the infant acquires a longer sleeping period, ordinarily at about 16 to 26 weeks.

Another aspect of self-demand—allowing the baby to eat as much as he likes at a feeding within reason—seems to us to be sensible. Babies on the breast vary their intakes widely, sometimes taking as little as 2 ounces at one feeding and 8 ounces at another. It has been our practice to prescribe a regular amount of formula per 24 hours, to be divided equally among the feedings. The mother is then told about the varying appetite of the baby at different times of the day and she is instructed to give more at a feeding when the baby is hungry and not to insist on a full feeding when the baby does not seem to want it. In our experience, this is more satisfactory than having the mother fill an 8-ounce bottle with formula and letting the child take as much as he will.

A word of caution is necessary. The effort, in self-demand feeding, is to satisfy the hunger-demands of the baby in a natural way. It is not possible to duplicate a "natural" situation when feeding cow's milk from a bottle to a baby. Even many breast-fed babies take more than they can retain; hence the old saying that a vomiting baby gains well. The cautious physician, aware of the tendency of young babies to stool frequency, may hesitate to give a month-old baby all the cow's milk that he seems to want.

A modified self-demand feeding schedule is satisfactory in most instances, but its success depends, to a large extent, on the personality of the mother and her reaction to self-regulation.[9] For one reason or another many mothers find the task of individualizing child

rearing a source of great anxiety. In certain instances, the fault lies in deep-seated emotional difficulties, and parenthood simply gives direction to the mother's inner tensions. But most of these anxious mothers are quite normal as indicated by their much more relaxed attitude toward subsequent children. Unaided by the sanction of a traditional approach, they are overwhelmed by a task which they are, for the time being, unable to handle.

The method of child rearing must suit the maternal temperament and cultural background. Individualization is fully as necessary in dealing with the mother as it is with the child. If the physician is convinced that self-regulation is going to make the mother overly anxious or otherwise unhappy, more or less specific directions should be given. An approach which she finds uncongenial will not only disturb her emotionally, it will make her task more difficult and will probably create unnecessary tensions in the child. It is unwise to try to coerce a mother who, by training, previous experience, or temperament, needs detailed instructions. Insistence that she take on, at once, the full responsibilities implied in motherhood serves only to increase her uncertainty, to undermine her self-confidence, and to lessen her efficiency.

This is not to say that we are to yield readily to mothers who prefer to shift their maternal responsibilities onto the physician. Most of us find it easier to take orders than to make decisions. Parenthood, after all, necessitates taking responsibility and parents will do well to learn this lesson early. But the physician will need to discriminate between those mothers who are ready for self-regulation and those who need the extra support which they get from more or less precise prescriptions.

The third aspect of self-regulation—more or less free choice of the type of food—ordinarily becomes a consideration only after the introduction of solid foods. Though the taste apparatus is well developed at birth the mixtures offered young infants are accepted without great regard for their taste.

According to Gesell and Ilg,[10] cereal is usually a favorite food during the first year of life, but even here preferences as to the type of cereal may appear as early as 24 weeks. Bananas and "jello" are general favorites during the first year. Likes and dislikes are shown early for vegetables. These attitudes are not necessarily permanent and considerable shifting back and forth may take place. Consistency and temperature of the food may be factors as well as taste.

When solid foods are introduced, the parents are told that no particular food is essential for the infant. If a food is refused, the method of preparation and administration should be investigated. If these are satisfactory, a substitute may be offered. If the child continues to refuse, attempts at giving solid foods may be deferred for several weeks and the parent told that the age at which infants are ready to accept solid food varies considerably. The parent should be warned against being too insistent or showing too much concern.

The Introduction of Solid Food

The optimal time to introduce solid foods is when the oral musculature of the infant is ready to receive it, generally between three and four months. This is not to say that solid food cannot be fed earlier. It can and often is. But, because the infant is not ready, feeding is difficult, the baby often ejecting the food owing to awkwardness of the tongue and lips. The mother may become tense, anxious, worried. This is unnecessary and can be avoided if the physician is willing to wait for the proper time.

Young infants push vigorously with the tongue against a spoon or solid food placed between the lips. At about three to four months, a change takes place. When food is brought to the child's mouth, the lips part, the tongue carries the food to the back of the mouth and swallowing follows. This is the optimal time to introduce solid food, and nothing is to be gained by earlier administration.

Gesell and Ilg find that solids are best accepted in the beginning at the evening meal when the infant is "more sociable and more experimental in mood." Once the child has been accustomed to taking solid food, all of the mushy foods may be given.

Foods that require chewing may be introduced at seven to nine months, even though no teeth are present. An undue delay here is sometimes associated with poor chewing later on.

Summary

Infant feeding is reviewed in the light of current knowledge about child development.

Breast-feeding is recommended. Aside from the psychologic implications, which may be significant in individual instances, breast- and bottle-fed infants show definite somatic differences in chemical constitution, in metabolic response (to lactose and to ascorbic acid administration), and in resistance to disease.

A modified self-demand feeding is recommended which relates to the amount and, later on, the types of food, the intervals between feedings being kept fairly constant.

In giving advice for infant feeding, it is fully as important to consider the personality of the mother as the child.

The optimal time to introduce solid foods is when the infant is developmentally ready, as shown by a change in oral behavior—about 12 to 16 weeks.

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Resumen

Alimentación infantil

Se considera la alimentación infantil a la luz del conocimiento actual del desarrollo infantil.

El amamantiamento se recomienda. Además de las implicaciones psicológicas que pueden tener importancia en casos individuales, los lactados al pecho y los artificialmente lactados muestran diferencias somáticas cuanto a su composición química y su respuesta metabólica (a la administración de lactosa y de ácido ascórbico).

Se aconseja una modificación de la alimentación autoregulada, cuanto a la cantidad y, más tarde, al tipo de alimento, quedando más o menos constantes los intervalos entre las comidas.

Cuando se hace recomendaciones para la alimentación del lactante hay que tener en cuenta no sólo el bebé sino también la personalidad de la madre.

El momento óptimo para la introducción de los alimentos sólidos se presenta cuando el desarrollo del nino está bastante avanzado, eso es, cuando un cambio en su comportamiento oral lo demuestra—a las 12 o 16 semanas, por lo común.

NUTRITION *in* POLIOMYELITIS

By GEORGE J. BOINES, M.D.*

POLIOMYELITIS is a systemic disease of virus etiology involving primarily the central nervous system and the voluntary muscular system. It is essentially a complex medical problem which requires intelligent medical management and competent nursing care for best clinical results.

Clinically, poliomyelitis may be either abortive, nonparalytic or paralytic. The paralytic types may be spinal, bulbar, or encephalitic, in the order of their greatest frequency. Recovery is spontaneous and apparently complete in only the abortive type.

The prominent symptoms are common to the nonparalytic and paralytic types of poliomyelitis. These include fever, headache, gastrointestinal disorders such as nausea, vomiting, and diarrhea, symptoms of the common cold, sore throat, malaise, considerable apprehension, muscle pain and muscle spasm, and stiffness of the back and neck. There is no loss in muscle power in the nonparalytics, but there is muscle weakness or paralysis in the paralytic patients.

The previous clinical management of poliomyelitis consisted of complete bed rest, immobilization, and splinting of the affected parts which resulted in what Ransohoff[1] so aptly termed "physical stagnation." Treatment was usually directed mainly to the neuromuscular aspects of the disease, with a consequent neglect of the patient's nutritional status.

After many years of studying the problem and evaluating the conclusions clinically, we[2] recommend that poliomyelitis be treated by: (1) early ambulation; (2) muscle relaxation; (3) controlled prolonged medical observation in order to attain maximum recovery and function of the neuromuscular power still retained by the patient; and (4) special nutrition program. Muscle relaxation is best obtained by the use of curare according to the technique originally described by Ransohoff[3] and modified by us. When relaxation has been achieved so that there is a complete range of motion of all joints, the curare is discontinued and prostigmine is instituted[4] in order to increase muscle strength and co-ordination. The physical therapy outlined by Ransohoff and the exercises described and illustrated by Billig and Loewendahl[5] have proved effective in our therapeutic regimen. Personal assistance and walking aids are used to facilitate early ambulation.

The application of *nutritional knowledge* to support the body mechanisms in disease has not received adequate attention. The role of nutrition as an integral part of the therapeutic regimen in poliomyelitis unfortunately either is not fully appreciated or is not generally understood. McLester[6] points out: "Nutrition is often a determining factor in recovery from disease. This has been slow of recognition and even today it warrants repeated emphasis." In poliomyelitis, specifically, the problem of disturbed muscle metabolism and protein depletion can be reversed in part with nutritional supplements. Increased protein intake is the crux of our nutritional program.

ROLE OF PROTEIN

We are all aware of the fact that one of the fundamental defenses of the body is dependent upon the presence of antibodies in the tissues and body fluids. Since antibodies are proteins, there seems to be no other mode of antibody synthesis but from dietary protein. According to Cannon,[7] this leads to the obvious conclusion that consumption of an adequate diet is "sine quo non" for protein repletion if the

* Attending Chief of Communicable Diseases and Poliomyelitis at the Wilmington General and St. Francis Hospitals. Lecturer at the Department of Biological Sciences, University of Delaware, Newark, Delaware.

body's acquired resistance is to be maintained.

The importance of protein in the defense against infection has been shown repeatedly.[6-8] Cannon and his associates[9-11] demonstrated the relationship of kind and amount of protein diet to antibody synthesis and resistance to infection. According to Cannon,[12] one portion of the serum protein (the globulin) carries with it various antibodies against infectious agents. It is not surprising therefore that protein undernutrition may be associated with susceptibility to bacteria and viruses. According to Wohl *et al.*,[13,14] "For effective production of antibodies it is necessary to restore protein reserves; if the capacity for protein synthesis is not defective, repletion and improved production of antibodies may be expected." Guggenheim and Buechler[15] concluded from their studies that: (a) the humoral defense mechanism appears to be more sensitive to protein deficiency than the cellular defense mechanism; (b) different food proteins elicit different bactericidal and phagocytic powers (this quality of promoting antibacterial defenses corresponds to the growth-promoting quality of the respective proteins); and (c) immune globulin is dependent for its formation upon the protein reserves and the protein intake.

During the febrile stages of most acute infectious diseases, both total metabolism and nitrogen metabolism are considerably increased.[16,17] Under ordinary conditions of feeding this results in a negative nitrogen balance with consequent waste of protein. This has been designated as the "toxic destruction of protein," and is apparently the result of combined effects of increased caloric expenditure and destruction of tissue. The destruction of protein appears to parallel the intensity or severity of the infection with which it is associated.

Metabolic disturbances caused by infection will lead to depletion of protein reserves which may be particularly hazardous in times of metabolic stress. That serum protein levels drop in various acute infections has been established. Eaton and Bower[18] referred to this phenomenon as "the reaction of injury" or the "catabolic phase of injury." Bower *et al.*[19] concluded from a study of a group of acute poliomyelitis cases that: (1) the greater the clinical severity and involvement of the case, the more consistently will the serum albumin levels drop below normal. This drop occurs early, between the first and third day, and progresses unfavorably until the tenth day at least; (2) the deviation of the serum protein values from normal bears a linear relationship to clinical severity, i.e., the more severe the clinical involvement, the less the amount of serum albumin present. According to Whipple,[20] the production of plasma protein, which contributes freely to the formation of globin and hemoglobin, is depressed by infection.

The catabolic phase during the course of disease was thought to be irreversible; however, Co Tui,[21] on the basis of his studies, holds that if such a catabolic factor is present, its effect can be counterbalanced by increasing the level of protein intake. He has even hypothesized that each disease entity has its own specific range of protein catabolism and, therefore, would require its own specific range of protein and caloric intake to maintain the protein status.

Vitamins

McCormick[22] offered a concept that "the paralytic phenomenon in poliomyelitis may be directly referable to acute B_1 avitaminosis precipitated by converging factors which increase the metabolic rate and accordingly the bodily requirements for this vitamin . . . and that the paralysis may be a secondary metabolic manifestation rather than a primary infectious disease."

An apparently increased resistance to the Lansing strain of poliomyelitis virus in experimental mice on vitamin B-deficient or restricted food intake was reported by Foster *et al.*;[23] however, they stated that their findings were difficult of interpretation and inconclusive, and intimated additional experimentation was needed to clarify the problem. In another experiment[24] they found no evidence that combined deficiency of phosphorus and vitamin D protected mice to any degree against poliomyelitis virus, although the ani-

mals were in a state of advanced deficiency; in fact, they were more susceptible than the controls on complete diets. Increase in susceptibility to the virus was greatest in the most deficient diets. This was particularly true in diets deficient in both phosphorus and calcium.

The influence of thiamine deficiency on the susceptibility of monkeys to experimental poliomyelitis was studied by Clark *et al.*,[25] who concluded that "this species when deficient in thiamin does not exhibit an increased resistance to poliomyelitis virus." The difference in response shown on the one hand by mice and on the other hand by cotton rats, even though they were subjected to similar nutritional stresses and inoculated with the same strains of viruses, led Weaver[26] to conclude that "this illustrates the danger of applying directly to human beings the results of animal experimentation."

Mathews[27] has called attention to the very close similarity of the neuropathological changes found in poliomyelitis and those produced by lack of vitamin B. He suggested that the destructive changes in poliomyelitis may be brought about in an indirect way by the intracellular vitamin B-depleting effect of the infectious agent.

We cannot subscribe to the concept that vitamin deficiency, be it thiamine or any other vitamin, represents a specific etiologic factor *per se* in poliomyelitis. We do believe, however, that thiamine and riboflavin are related to protein synthesis in the body, and any deficiency will interfere with this essential process.

Muscle Wasting

One of the essential problems in poliomyelitis is wasting of muscle tissue. Although the mechanism is uncertain, it has been suggested[28] that the muscle tissue may be directly invaded by the virus. Additional contributing factors may be dietary inadequacy, fever, anorexia, nausea and vomiting in the course of the acute phase, the catabolism attributed to the over-secretion of catabolic hormones by the adrenals as part of the stress reaction, and immobilization of the patient.

It was generally accepted that weight loss was inevitable in poliomyelitis as a result of the destruction of the anterior horn cells, thus producing muscle atrophy by denervation. In following the patients in our clinic from the onset of the disease to functional restoration, we observed that those with the most extensive paralysis suffered the greatest weight loss—anywhere from ten to forty pounds—during the first three to six weeks. This may be ascribed to bed rest and inactivity, a decrease in appetite, and to destruction of tissue due to denervation. The muscle atrophy associated with poliomyelitis represents to us evidence of loss of plasma proteins as well as tissue proteins. With a depletion of these proteins the patient becomes weak, loses weight, and suffers a reduction in muscle mass. If this phenomenon is not attended to, further complications of protein deficiency will evolve, resulting in prolonged convalescence and additional muscle weakness and paralysis.

It is not often realized that an increased nutritional intake is essential in any infection, and, especially, in the acute and convalescent poliomyelitis patients. For effective tissue synthesis, two dietary essentials, proteins and calories, are mutually indispensable. Adequate nutritional intake is even more important for the convalescent patient than it is for the normal, healthy individual. It should be borne in mind that in poliomyelitis muscle metabolism is seriously disturbed. Considerable loss of muscle protein results from bed rest, and if we add to this the loss of plasma protein as a result of the acute infection, the protein requirements of the patient are greatly increased. This increased demand must be satisfied.

The extensive muscle spasm which is always present in poliomyelitis interferes with the circulation and, thus, nutrition of the muscle. Energy-producing substances, such as adenosine triphosphate and phosphocreatine, protein derivatives, are interfered with or reduced.[29] Blood sludging[30,31] and increased capillary permeability further interfere with muscle nutrition.

Present Program

We deem it imperative to institute a nutritional program as soon as the patient is ad-

mitted to the hospital in order to arrest, if possible, the early rapid weight loss. We are in agreement with Co Tui that the tendency to catabolism may be counterbalanced by increasing the level of protein intake. Our objective is to restore muscle mass and strength as quickly as possible without the deposit of excess fat. Such fat is a liability in the presence of weak or paralyzed muscles. When wasted muscles are to be reconstituted, as in poliomyelitis convalescence, both the quantities and proportions of all indispensable amino acids must be adequately supplied in the daily diet, together with calories, vitamins, and minerals.

We strive to make the patient ambulatory at an early date to enable him to participate intensively in exercise programs without premature fatigue, and to assume more quickly his place in school or work activities. Patient progress is measured by total urinary nitrogen, urinary creatine excretions, muscle testing, and weight readings taken at fixed times daily.

From a nutritional standpoint, our procedure with poliomyelitis patients includes an evaluation of the patient's physical status at the time of hospitalization, complemented with urine and blood studies. During the acute febrile stage, the patient is supplied with all necessary nutrients by the administration of glucose and protein hydrolysate parenterally, and, if the case is severe, blood plasma also. However, as in other types of nutritional therapy, good food by mouth, according to Stare and Thorn,[32] is the most effective and satisfying way to administer protein. While temporary therapy with protein concentrates of various types is often valuable and even necessary, it is only a highly nutritional diet over a long period which will give satisfactory results. Increasing the amount of protein in a diet is one of the best general ways to improve a diet. This we accomplish by adding a daily supplement to the routine hospital diet (Table I).

Nutritional support should begin when the patient arrives in the hospital, at the very onset of the disease, when the patient's system is under the terrific stress of the infection. The protein intake should be supplemented with fat and carbohydrates. The fat spares the protein by preventing its consumption for energy production and the carbohydrate spares the protein by relieving it of the necessity of providing carbohydrate. Hoesslin[33] found that the administration of a high caloric diet led to little increase of weight in protein-starved individuals if the high calories were given entirely as fat and carbohydrates. Only if the protein in the diet was also raised could they be made to put on flesh.

Hospital patients are frequently on a low intake not only of proteins but of total calories.[34] The general hospital diets are often calorically adequate, but according to Pollack and Halpern[35] are inadequate in proteins. This may be further complicated by the patient's failure to eat all of the food supplied at each meal, a situation particularly true in a pediatrics ward. Table II shows the nutrients in customary "routine" hospital diets. These are considered inadequate in protein and in calories.

Hospital diets do not furnish enough *protein* to supply the demand created by the disease process in poliomyelitis. We appreciate that no patient has the stomach capacity nor the gargantuan appetite to consume 150 to 300 Gm. of protein per day from kitchen-prepared food. Since Wohl *et al.*[13] have shown that casein-type protein supplements aid measurably in antibody formation in hypoproteinemic patients, we are able to depend on this type of supplement to obtain the thera-

TABLE I

Daily Supplement Added to Routine Hospital Diet

Supplement	Quantity used in daily mixture	Protein	Fat	Carbohydrate	Caloric value
		Gm.	*Gm.*	*Gm.*	
Fat emulsion	4 oz.	0	48	12	480
*Protein powder	2 oz.	42	0	13.2	220.8
Eggs	2	13.4	10.4	0	147.2
Corn syrup	1 oz.	0	0	22.2	88.8
Milk	1 qt.	31.6	38	48	660.4
Totals		87	96.4	95.4	1597.2

* Daily supplement drink mixture is best taken cold after meals and at bedtime. It may be fed by stomach tube in bulbar cases.

TABLE II

Routine Hospital Diets

Average weights		Average ages of patients	Protein	Fat	Carbohydrate	Protein	Fat	Carbohydrate	Total 24-hr. caloric intake
Lb.	*Kg.*	*Years*	*Gm.*	*Gm.*	*Gm.*	*%*	*%*	*%*	
29	13	1–2	45	70	125	15.5	36.3	48.2	1310
55	25	3–9	60	75	150	20	40	40	1515
85	39	10–13	75	100	200	15	44.5	40.5	2000
110	50	15	85	120	200	15	49	36	2220

TABLE III

Supplemented Diet used in Our Program Compared with Special Hospital Diet

Diet for 15 yr. old 110 lb. (50 Kg.) of weight	Protein	Fat	Carbohydrate	Protein	Fat	Carbohydrate	Total 24-hour caloric intake
	Gm.	*Gm.*	*Gm.*	*%*	*%*	*%*	
Routine hospital diet (Table II)	85	120	200	15	49	36	2220
Our supplement added (Table I)	87	96.4	95.4	21.2	54.5	24.3	1597
Total supplemented diet used	172	216.4	295.4	18	51	31	3817
High protein high caloric hospital diet	144	135	486	16	32	52	3775

Note the *increase* in protein and fat and *decrease* in carbohydrate in our supplemented diet as compared with the hospital diet.

Patients find it difficult to consume all of the kitchen-prepared food in a high protein, high caloric hospital diet. There is less resistance in the feeding of the routine hospital diet plus four or more glasses of cold, flavored "milk shake" mixture.

peutic benefits of high protein intake. Waife *et al.*[36] found that patients whose protein intake was supplemented by an oral concentrate preparation stored large amounts of nitrogen. This avidity for protein reached high proportions in certain chronically ill individuals, even after months of presumably adequate protein intake.

A survey of protein supplements was made and two preparations have been selected because of their high biologic values and their palatability. To supply the additional calories deemed necessary to spare protein, we selected an oral fat emulsion* which was readily accepted by a majority of the patients.

On arrival at the hospital, each patient's physical status is evaluated, and the nutritional program is arranged. We supply all necessary nutrients during the acute phase in the form of glucose, protein hydrolysate, blood, and sometimes plasma, parenterally, and protein and fat emulsions orally. After the acute phase, the patients are put on general hospital diets which are supplemented with the casein-type oral protein concentrates.† Each meal was carefully evaluated for its caloric value represented by protein, fat and carbohydrate. It has been our procedure to check each tray as it is taken from the patient for the calories not consumed, and this aggregate difference between calories supplied and calories consumed is made up in an extra meal at night. The protein-vitamin preparations are prescribed in quantities to attain a level of at least 4 Gm. of protein per Kg. of body weight,

* Lipomul®—Upjohn Company, Kalamazoo, Michigan.

† Vi-Protinal®—The National Drug Company, Philadelphia, Pa. Provimalt®—Humanic Brands, Summit, N. J.

TABLE IV
Caloric Value of Supplements
Used in Poliomyelitis

Supplement	Quantity	Protein	Fat	Carbohydrate	Caloric value
		Gm.	*Gm.*	*Gm.*	
Fat emulsions	1 oz.	0	12	3	120
(Lipomul®)		0	15	3.6	150
(Ediol®)					
Protein powder	1 oz.	21	0	6.6	110
(Vi-Protinal®)					
(Provimalt®)					
Egg	1	6.7	5.2	0	74
Corn syrup	1 oz.	0	0	22.2	89
Milk	1 qt.	31.6	38	48	660

Nutmeg, vanilla, chocolate, or any other flavoring agent may be used. Shake thoroughly and serve cold.

fortified with oral fat emulsion to supply about 500 calories in addition to that obtained from the kitchen-prepared food (Table III).

The excellent cooperation of the nursing staff and the dietitians has made it possible for us to have a daily record of actual food consumption for each patient. We have achieved daily protein intakes up to 300 Gm. with very little or no patient resistance. The oral fat emulsion was added to milk with the protein-vitamin preparation. There were some complaints of fullness of the stomach, but this was not a serious problem.

Because of the early loss of weight (we have observed an average loss of 10 to 40 lb. during the first three to six weeks), it is imperative to start intensive feeding as soon as the patient is admitted to the hospital. As a result of our nutritional program, we have succeeded in having a large number of our patients maintain or gain weight during their hospitalization. This program is continued in ambulatory patients until maximum muscle strength and function have been attained. It must be emphasized here that our object is not to have the patient gain weight *per se*, but rather to maintain his muscle strength without the deposit of excess flabby fat.

It is important that the high protein intake program be carried over into the home care of the patient (Table IV). Not only should the family be instructed in the methods of preparing high protein foods and warned to withhold sweet drinks and candy from the patient, but should also be instructed in the importance of continuing the supplemental protein feeding as part of the diet, especially with those patients who continue therapeutic exercises. It will definitely aid if the family fully understands the particulars of the patient's need for protein.

Capillary Permeability

Capillary permeability may be increased in poliomyelitis as a result of the infection or the toxemia of the infection. According to Harrell and Aikawa,[37] intelligent management, with attention to alterations in the permeability of membranes, will lessen the severity of the patient's resistance to his infection, and will shorten convalescence.

There are a number of reports[38-44] to indicate that Hesperidin, a flavonone derived from citrus fruits, combined with vitamin C, when used in adequate doses, corrects the increased capillary fragility and permeability found with various disease entities. On the basis of these reports, we have been using Hesperidin-C,®† from 8 to 12 tablets or capsules daily, in all of our poliomyelitis patients. We intend to pursue this phase of our procedure further in a future study.

Conclusions

Since the institution of our nutritional program we have arrested the loss of body weight

† Hesperidin-C® (Hesperidin, 50 mg., Vitamin C, 50 mg.)—The National Drug Company, Philadelphia 44, Pa.

at a much earlier date in the process of the disease than has heretofore been observed, and have succeeded in having our patients retain their normal weight, yes, even gain weight, during their hospitalization. It is our impression that our therapeutic procedure emphasizing nutrition in the management of poliomyelitis has resulted in superior clinical results as evidenced by reduced severity of the acute phase, minimal weight loss, minimal disabling muscle atrophy and ankylosis, accelerated convalescence, reduced incidence for corrective surgery, and favorable results in functional restoration of affected parts.

We are in agreement with Elkins[45] that the responsibility for care of the poliomyelitis patient should be entirely in the hands of the physician. Treatment must be highly individualized and adapted to the patient's needs. The poliomyelitis patient is justified in feeling that his physician should be one who has studied the anatomic function of normal muscles, who has seen many forms of paralytic disabilities, and who can apply wisely his knowledge and experience.

The importance of nutrition is well expressed by Whipple and Madden,[46] who stated: "The circulating plasma protein is the medium of exchange and the body is solvent just so long as there are adequate proteins supplied for any emergency. When the body becomes insolvent, there may be foreclosure due to disease, infection, or injury." It is to keep the body solvent in poliomyelitis that we stress the importance of therapeutic nutrition.

The tremendous importance of maintaining optimal muscle metabolism by correcting the underlying biochemical and physiologic disturbance should be emphasized. Success stems from directing attention to early ambulation, to muscle relaxation by curarization and an active exercise program, to extended medical supervision—and particularly to therapeutic nutrition.

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Resumen

La nutrición en la poliomielitis

Con la institución precoz de su régimen nutritivo en el tratamiento de la poliomielitis

el autor ha conseguido suspender la pérdida de peso de sus pacientes a una fecha mucho más temprana en el curso de la enfermedad de lo que se había observado antes, e incluso ha logrado el mantenimiento del peso normal y aun un aumento ponderal en sus pacientes hospitalizados. Asimismo ha notado: reducida severidad de la fase aguda; mínimum de atrofia incapacitante de los músculos y de anquilosis; acelerada convalecencia; reducida incidencia de cirugía correctiva; y resultados favorables en la recuperación de los órganos afectados.

El autor insiste en la importancia de un óptimo aporte de proteína y el mantenimiento así del metabolismo por la corrección del disturbio bioquímico y fisiológico subyacente. Ya en la fase aguda se administran todos los nutrimentos esenciales: glucosa, hidrolizados de proteína, sangre, y a veces plasma (por vía parenteral); proteína y emulsiones de grasas (por vía oral). Terminada la fase aguda, se suplementa a la dieta hospitalitaria con concentrados de proteína, tipo caseína, por via oral. Los preparados de proteína y vitaminas se dan en cantidades capaces de lograr el nivel mínimo de 4 gramos de proteína por kilo de peso, y se les añaden emulsiones de grasas hasta proveer unas 500 calorías además de las provistas por las comidas. Con tal régimen se ha conseguido un consumo diario de hasta 300 gramos de proteína.

Research—an Attitude

"The conventional picture of the research worker is that of a rather austere man in a white coat with a background of complicated glassware. My idea of a research worker, on the other hand, is a man who brushes his teeth on the left side of his mouth only so as to use the other side as a control and see if tooth-brushing has any effect on the incidence of caries."
—R. Platt. *British Medical Journal,* March 14, 1953.

The Art of Observation

"Fascination of the present day medical student and his teachers with rubrics and rituals of science, techniques and laboratory procedures has left the less spectacular and certainly far from miraculous gleanings of observation for the few remaining physicians, perhaps we should call them medical recluses, who are natural historians of disease. . . .

"Research is not initially and not necessarily a thing of apparatus and abstruse formulae. The incubus of technical virtuosity, unillumined by the constant refreshment of bedside observation and questioning may slow rather than speed the progress of medicine. But equally true is the limitation of mere observation, which cannot quest beyond the brilliance of a Vesalius to the genius of a Harvey or Bernard. Observations must arouse speculations which give birth to hypotheses, which in turn require experiments to judge them, be they right or wrong. The historic logic of investigation demands that it arise from ideas, not from tools. And ideas come from observation and thoughtful contemplation."
—William B. Bean. *Quarterly Bulletin of Northwestern University Medical School* 27: 89, 98, 1953.

Tribal NUTRITION *and* HEALTH *in* NIGERIA:

A Comparative Clinical Study of Primitive and Urban Nutrition

By BRUCE M. NICOL, M.D.*

NUTRITIONAL problems, particularly in tropical areas, are intimately involved with genetic, climatic, and parasitic factors. Opportunities for comparative evaluation of such factors do not frequently present themselves. However, the author has had the opportunity of studying the nutritional status of three West African native groups, genetically similar and living in the same climatic area—a group of fishermen, farmers, and wealthy traders.

The work upon which this paper is based was carried out in Nigeria in 1950 and 1951 among primitive tribes, who live in the delta of the Niger River. It forms part of a wider study[1,2] designed to correlate the state of health of Nigerian peasants and their present diets. The Ijaw fishermen live on the banks of the mangrove-fringed creeks which flow into the Gulf of Guinea, and the Isoko farmers cultivate small fields in the fresh water swamps and tropical rain forest some fifty miles inland from the coast. The health and nutrition of the two tribal groups were compared with data obtained from a group of Negro traders. The latter are wealthy Africans living under more civilized conditions and domiciled in the town of Warri, a provincial headquarters with a population of about 15,000.

METHODS OF INVESTIGATION

Full details of the methods employed to measure the food intake and physical status of the groups under study have been published elsewhere.[1,2] Briefly, the foods prepared for cooking in three kitchens in each of two remote villages, one Ijaw and one Isoko, and in the town of Warri, were weighed and measured during four periods of a week each throughout one year. The study was confined to individuals between the ages of 13 and 23, who represented samples of the three classes observed; namely, wealthy traders, fishermen, and peasant farmers.

Clinical examinations were carried out on samples of each of the three groups, and the degree of protozoal and helminthic infestations was assessed. The mean daily intake of foodstuffs *per caput* for each group throughout the year was calculated from the figures obtained for the four periods of investigation, and the nutrient and energy values of the diets were determined by using tables of representative values,[3,4] additional values being taken from Nicholls,[5] McLester,[6] and other sources. The methods used to process and prepare foods for cooking were recorded and allowance made for these factors in the nutrient determinations.

All these investigations were either performed by the author or closely supervised by him. It is unlikely that the food consumption studies give an exactly accurate picture of the overall daily intake of the tribes in question, but it is believed that the major differences of nutrient intake between one group and another are real, and conclusions have been drawn only from such differences.

RESULTS

Nutrient Values of the Diets

The composition of the diets in terms of foodstuffs and nutrients is shown in Tables I

* Colonial Medical Service, Nigeria.

TABLE I

The Foodstuffs Ingested by Two Nigerian Tribes and by One Group of Wealthy Traders, All Living in the Niger Delta, Showing the Sources of Protein in These Diets

Foodstuff: grouped	Ijaw Fisherman			Isoko farmers			Warri traders		
	Amount	Protein Animal	Protein Veget.	Amount	Protein Animal	Protein Veget.	Amount	Protein Animal	Protein Veget.
	Gm.	*Gm.*	*Gm.*	*Gm.*	*Gm.*	*Gm.*	*Gm.*	*Gm.*	*Gm.*
Starchy roots	462	0	7	1030	0	15	550	0	8
Cereals	15	0	2	36	0	3	186	0	16
Legumes	0	0	0	13	0	3	15	0	4
Oil seeds and nuts	2	0	*	6	0	1	13	0	2
Red palm oil	27	0	0	35	0	0	36	0	0
Sugar cane stem	4	0	*	3	0	*	26	0	*
Leaves, fruit, and vegetables	6	0	1	12	0	1	115	0	2
Palm wine or beer (ml.)	103	0	1	250	0	3	220	0	1.5
Distilled spirits (ml.)	107	0	0	13	0	0	84	0	0
Imported jams	0	0	0	0	0	0	8	0	*
Tea and coffee	0	0	0	0	0	0	7	0	0.5
Fish, lake, fresh	165	27	0	18	3	0	62	10.5	0
Fish, lake, dried	78	39	0	18	9	0	28	14	0
Shell fish	12	2	0	0	0	0	2	*	0
Other animal foods	0	0	0	36	8	0	145	23	0
Milk, imported, evaporated, and sweetened condensed	0	0	0	0	0	0	33	2.5	0
Total protein		68	11		20	26		50	34

* Negligible amounts.

and II, along with the sources from which protein is obtained. The tables illustrate the low protein content of starchy roots. In Tables III and IV the amounts of protein, calories, and B-complex vitamins are compared with National Research Council[7] recommended daily allowances, taking into account body weight and reduced metabolic activity due to tropical environment.[8]

It will be noted that the diet of the Warri traders supplies adequate amounts of all of the nutrients covered by the analysis, with the exceptions of thiamine and riboflavin, which were found to be slightly less than the NRC

TABLE II

Calculated Adult Daily Nutrient Intakes of Nigerian Traders and of the Ijaw and Isoko Tribes*

Group	Calories	Protein An.	Protein Veg.	Fat	Carbohydrate	Vitamin A†	Thiamine	Riboflav.	Nicotinic acid	Ascorbic acid	Fe	Ca
		Gm.	*Gm.*	*Gm.*	*Gm.*	*I.U.*	*Mg.*	*Mg.*	*Mg.*	*Mg.*	*Mg.*	*Mg.*
Ijaw	2153	68	11	39	379	5655	0.30	0.68	12.1	40	24	2891
Isoko	2267	20	26	43	424	7348	0.69	0.65	8.9	30	21	664
Traders	3003	50	34	86	473	9206	1.02	1.37	18.1	71	21	1302

	Contribution to total Calories (%)			Composition of Diets (% by weight)		
	Protein	Fat	Carbohydrate	Protein	Fat	Carbohydrate
Ijaw	14.6	16.4	69.0	16.1	7.8	76.1
Isoko	7.7	17.0	75.3	8.4	8.4	83.3
Traders	11.2	25.8	63.0	13.1	13.4	73.5

* No allowance made for the destruction of nutrients by cooking.

† 1 I.U. of preformed vitamin A taken as equivalent to 3 I.U. of vitamin A in the form of carotene.

TABLE III

Calculated Amounts of Protein and Calories Supplied by the Diets per Lb. Body Weight, Compared with the NRC Recommendations for Moderately Active Men and Women of Mean Weight 139 Lb., 12½% Reduction Being Made for the Effect of Climate upon Total and Basal Metabolic Rates (Keys 1949)

	Mean weight, male and female	Calories	Total protein	Animal protein	Vegetable protein
	Lb.		*Gm.*	*Gm.*	*Gm.*
Ijaws	119	18.4	0.67	0.57	0.10
Isokos	111	22.9	0.39	0.15	0.24
Traders	136	22.1	0.62	0.37	0.25
NRC* allowances	139	17.0	0.47	0.31	0.16

* National Research Council.

TABLE IV

Calculated Amounts of Thiamine, Riboflavin, and Nicotinic Acid in the Diets of Warri Traders and Ijaw and Isoko Tribes, Expressed as Mg./Lb. Body Weight and as Mg./1000 Calories in Each Diet

	Thiamine		Riboflavin		Nicotinic acid	
	Mg./lb. body weight	Mg./1000 Calories	Mg./lb. body weight	Mg./1000 Calories	Mg./lb. body weight	Mg./1000 Calories
Ijaws	0.002	0.14	0.006	0.310	0.10	5.5
Isokos	0.006	0.31	0.006	0.288	0.08	4.0
Traders	0.008	0.34	0.011	0.456	0.13	6.0
NRC* allowances	0.010	0.50	0.012	0.611	0.09	5.0

* National Research Council.

recommendations, but well above those found by many workers to prevent symptoms of deficiency in temperate environments. The nutrient intakes of the primitive Ijaw and Isoko tribesmen differ in certain respects. The former tribe (largely fishermen) eat large amounts of animal protein but little vegetable protein, whereas the Isoko tribe (largely farmers) eat much less protein, of which only 44 per cent comes from animal sources. The calcium intake of the Ijaw fishermen is high, as much of the fish they eat is dried and contains small bones which are not rejected. However, the Ijaw diet is particularly deficient in thiamine.

The quantities of nutrients recorded in Table II were those present in the food before cooking. As very little green vegetables, fruit, or roots were eaten raw, and as boiling in open pots was the method of cooking commonly employed, it is probable that at least two-thirds of the ascorbic acid and a proportion of the thiamine were destroyed before ingestion. Fish were seldom eaten raw, and it is not considered that serious losses of thiamine result from enzymatic activity.

Clinical Data

The incidence of parasitic infestations, which always confuses nutritional studies carried out in the tropics, is given in Table V. The degree of infestation in the three groups under consideration was the same and it is unlikely that they affected the nutritional status of one group more than another.

It is not proposed to consider in this communication all the manifestations of undernutrition which these tribes present, as this has been done elsewhere.[2] The clinical data which will be discussed are set out in Tables VI to VIII and cover the general appearance and average weights of the three groups, the incidence of fully developed vitamin deficiency syndromes, certain mucocutaneous lesions attributable to low intakes of particular nutrients, and the incidence of disorders of the liver. It is notoriously difficult for one examiner to record with consistency the general appearance of individuals who form a sample of a population. Throughout this study care was taken to refer constantly to photographs of the individual under study and the physical and mental development of the African who assisted at all

TABLE V

Percentage Incidence of Parasitic Infestations in One Group of Traders and Two Tribes, All Living in the Niger Delta

	Traders (100)*	Ijaws (150)*	Isokos (150)*
	%	%	%
Ankylostomiasis	73	96	95
Ascariasis	17	20	31
S. Mansoni	0	0	1
S. Haematobium	1	0	1
E. histolytica	4	8	5
Splenic index children 2–10 years	17	17	22

* Number of people examined for parasites in each group.

examinations was also used as a standard reference of health.

Discussion

General Appearance

The dietary studies carried out upon the wealthy negro traders show that this group consume a diet which was similar in pattern to those consumed by Europeans living in Nigeria. It supplied nutrients in excess of NRC allowances, with the exceptions of thiamine and riboflavin. The daily intake of these two nutrients, however, does not fall far short of the recommendations of the NRC. The clinical data collected from the traders (Tables V to VIII) showed them to be in reasonably good health. Their average weight was only slightly below that of Caucasian races of the same age groups, and only a small percentage showed any of the mucocutaneous lesions attributable to nutritional deficiency. They suffered from hepatic disorders to some extent, but infective hepatitis was common throughout the Niger Delta, and their intake of alcohol was considerable. These traders attained a satisfactory state of health, despite infestation with parasites which were no different from those found in their less fortunate brothers who lived under primitive tribal conditions.

Consideration of these observations leads to the broad conclusion that African peasants can maintain a good standard of physique and health in Africa provided they eat well. Neither genetic, climatic, nor parasitic factors prevent normal growth and development if an adequate supply of nutrients is available and utilized.

In view of the marked differences in the caloric and nutrient composition of the two diets (Tables II and VI), it is surprising that on inspection the Ijaw fishermen appeared to be the physical equals of the traders. Although the traders tended to look fat and prosperous and the Ijaws lean and athletic, an impression of fitness and mental alertness was noted in approximately 70 per cent of both groups. In comparison, the Isoko farmers' appearance contrasted poorly with that of the Ijaws; only 38 per cent of the former appeared to be fit and the majority behaved in an apathetic and uninterested manner while being examined and questioned. Such mental apathy, associated with irritability and attacks of rage or mania, have been attributed to lack of B-complex vitamins. The subject has been reviewed recently by Wilder.[9] The results of the rages and maniacal tantrums from which the Isoko suffer from time to time are well documented by the local police and by the records of the supreme court. It is surprising that this aspect of B-complex deficiency was more common and more developed among the Isoko farmers than among the Ijaw, as the latter's diet contained less thiamine.

Neither diet contained an excess of ascorbic acid, which is known to compensate to some

TABLE VI

General Appearance, Incidence of Vitamin Deficiency Syndromes and Mean Hemoglobin Levels in One Group of Traders and in Two Tribes Living in the Niger Delta

	Traders (64)*	Ijaws (80)*	Isokos (80)*
	%	%	%
General appearance			
Good	70	67	38
Fair	26	30	56
Poor	4	3	6
Beriberi	0	0	1
Pellagra	0	0	0
Scurvy	0	0	0
Mean hemoglobin†	82	76	70
Standard deviation	11.80	11.80	10.60
Standard error of mean	1.48	1.32	1.19

* Number of people examined.

† 100% hemoglobin = 14.8 Gm./100 ml. blood.

extent for low levels of B-vitamins[10,11] in a diet. Apart from the well-known tryptophane-niacin relationship, biochemical evidence exists which shows that less thiamine is required in diets which are high in protein and low in carbohydrate than in diets which are high in carbohydrate and low in protein, the fat content being equal.[12-14] The protein content of the Ijaw diet (fish) was considerably higher and the carbohydrate content somewhat lower than in the Isoko diet, but the differences were much less than applied in the animal experiments quoted. Work on the amino acid composition of the tribal diets is in progress, and it is hoped to discuss such nutrient interrelationships more fully in a subsequent publication.

Body Weight

The mean weights of the Ijaw and Isoko tribes, taken from large samples were 119 lb. and 111 lb. respectively, the differences being statistically significant (Table VII). As the diets of these two tribes supplied essentially the same quantities of calories and nutrients, with the exception of protein and calcium, it is considered that the greater weight of the Ijaws is a reflection of the greater amounts of protein and calcium which they ingested. In the absence of data relating to the amino acid composition of the proteins in the diets, it is impossible to say whether the good development of the Ijaws is due to the larger total protein intake, to a more physiological mixture of essential amino acids in the animal protein of their diet, or to some factor other than amino acids which is associated with animal protein, e.g. vitamin B_{12}.

TABLE VII

Mean Weights of Samples of Traders and Two Tribes Living in the Niger Delta

	Traders (484)*	Ijaws (757)*	Isokos (1085)*
Mean weight (lb.)	136	119	111
Standard deviation	22.90	12.65	15.85
Standard error of mean	1.04	0.46	0.48

* Number of people in the samples, aged 16 to 65 years.

The weights of the Warri traders averaged 136 lb. They were the only group of Negroes in which excess depot fat was observed regularly, and this is not surprising, in view of the fact that their intake of calories was high and that they took little exercise. Spare fat was never seen on the Ijaw and Isoko tribesmen, whose existence depends upon paddling canoes, swimming, or hoeing the soil. The energy expended by these two primitive tribes in obtaining the necessities of life apparently leaves little spare energy for amusement. In the seasons between hoeing, planting, and reaping, and in the height of the rains, when fishing is impossible, they make and mend nets, houses, and canoes, or clear fresh areas of bush for next year's farming. The only form of exercise in which they indulge socially is a little dancing, and this is not a highly developed art in the Niger Delta. Most of their spare time is spent lounging outside their huts on the village street. In Northern Nigeria, on the other hand, where the caloric intake is higher (around 3000 calories), the farmers amuse themselves by organizing competitions in the local forms of boxing and wrestling, at which sports they are very proficient.

Incidence of Specific Vitamin Deficiency Syndromes

In view of the exceedingly low intakes of thiamine and ascorbic acid supplied by the cooked diets of these tribes it is possibly surprising tnat beriberi and scurvy were very seldom seen among them. However, it is well to remember the length of time and the exceedingly low dosages of thiamine and ascorbic acid required to produce even minor degrees of these syndromes experimentally in man.[9,15,16] No doubt the Ijaws and Isokos would rapidly develop severe degrees of illness following complete withdrawal of thiamine and ascorbic acid, but the fact remains that they do not suffer from beriberi or scurvy while eating their natural diets, except under conditions of severe nutritional failure, such as famine. The same argument holds good for pellagra, but in this case their intake of nicotinic acid more nearly approaches the recommended allowances.

The first thorough studies of beriberi and pellagra in West Africans were done in 1912.

and cases were found in institutions such as prisons, where the diets were based on milled rice or maize, unsupplemented by any protective foods.[17] In Nigeria, the application of more recently acquired knowledge has led to the provision of prison diets which resemble more closely the natural diets of the local populations.[18]

Certain Mucocutaneous Lesions

In sharp contrast to the absence of beriberi, pellagra and scurvy was the high incidence among the Ijaw and Isoko of many surface lesions which have been attributed to nutritional deficiencies (Table VIII). These

TABLE VIII

Incidence of Certain Mucocutaneous Lesions in Samples of Traders and Two Tribes Living in the Niger Delta

Lesions	Traders (64)*	Ijaws (80)*	Isokos (80)*
	%	%	%
Skin			
Follicular hyperkeratosis	0	3	1
"Elephant skin" (marked)	0	0	0
Nasolabial seborrhoea	14	48	62
Permanent "gooseflesh"	6	29	25
Eyes			
Pigmentation of sclera	37	33	44
Superficial corneal opacity	2	10	9
Xerophthalmia	0	0	1
Photophobia	0	10	13
Lips and Tongue			
Angular stomatitis	4	53	56
Red sore-looking tongue	2	23	31
Magenta or lilac tongue	2	40	38
Atrophy of epithelium of tongue, all degrees	5	47	47
Longitudinal plus transverse fissuring of tongue	1	3	5
Other Features			
Calf tenderness easily elicited by pressure with hand	18	40	31

* Number of subjects examined.

lesions have been discussed in detail elsewhere.[2]

Three signs were seen with some frequency in the traders, namely: nasolabial seborrhoea, calf-tenderness, and pigmentation of the sclera. The first and second of these have been attributed to lack of riboflavin and thiamine, respectively. Permanent "gooseflesh" and angular stomatitis occurred in a very small percentage of the traders. From these observations it is concluded that the daily intakes of thiamine and riboflavin, namely, 1.02 mg. and 1.37 mg., respectively, are sub-optimal if taken over long periods in an African environment. Pigmentation of the sclera was found equally in traders, Ijaws, and Isokos, and is believed to be a racial characteristic rather than a nutritionally induced lesion.

The diets all contain ample amounts of carotene, and it is not surprising that clinical features of vitamin A deficiency were seldom seen. When they occurred, it was usually in association with severe liver damage, e.g. the one case of xerophthalmia recorded in the sample of the Isoko tribe. Weiss[19] termed the condition "opthalmia hepatica." The few cases of follicular hyperkeratosis noted may have been the result of ascorbic acid deficiency rather than vitamin A deficiency. It is difficult to see perifollicular hemorrhages in a pigmented skin.

The remaining signs mentioned in Table VIII, which occurred with great frequency among the Isoko farmers, have been attributed by various authors to deficiencies of either riboflavin or nicotinic acid. Most of them disappear after the administration of riboflavin and rather more quickly by a B-complex preparation. Riboflavin was "more deficient" than nicotinic acid in these diets, and the inclination is to blame a deficiency of riboflavin for the occurrence of these signs; but because data concerning other members of the B-complex are lacking, it is unwise to draw any definite conclusions.

The Incidence of Liver Disorders

Clinically demonstrable enlargement or reduction in size of the liver, accompanied or unaccompanied by ascites, was encountered with some frequency in the natives living in the Niger Delta area. As mentioned above, epidemics of infective hepatitis were common, and the consumption of alcohol was high in all sections of this population (Table I); parasites capable of causing serious hepatic lesions were frequently encountered; but these factors did not appear to bear a direct relation-

ship to the observed incidence of cirrhosis in the groups of adults examined. The incidence of this lesion was less in the traders and Ijaws than it was in the Isokos, and this leads to the conclusion that the most important factor in the prevention of cirrhosis in these natives is a high intake of protein. Consideration of the relationship, if any, between "kwashiorkor" in infancy and hepatic cirrhosis in adults is beyond the scope of this communication, but it is of interest that the hepatic and other lesions found in "kwashiorkor" can be corrected by the administration of adequate quantities of skimmed milk powder. In the present state of knowledge this, combined with elimination of protozoal and helminthic infestations, is the only satisfactory method of treatment.

Summary

The nutrient intake and nutritional status of two African tribes (Ijaw and Isoko) living in the Niger Delta area of Nigeria, West Africa, are described, together with the methods employed in their determination. The data are compared with those obtained from racially similar, wealthy traders living in the same area.

The evidence suggests that *neither* genetic, climatic, nor parasitic factors prevented the tribesmen from attaining a good standard of health and bodily development, *provided* an adequate supply of nutrients was utilized.

Consideration of the general appearance and behavior of the tribesmen and of their nutrient intakes suggests that their mental apathy and irritability were related to long continued deficiency of B-complex vitamins, in particular thiamine, and that a high intake of protein compensates to a considerable extent for this vitamin deficiency. Beriberi, pellagra, and scurvy were not seen in spite of low vitamin intakes.

The mean body weight of the Ijaw fishermen was significantly greater than that of the Isoko farmers, the difference being attributed to a greater intake of protein by the former.

The incidence and etiology of certain mucocutaneous lesions and the incidence and etiology of cirrhosis of the liver in these natives are considered.

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Resumen

Nutrición y salud de algunos tribús de Nigeria: Estudio clínico comparativo de la nutrición primitiva y urbana

Se describe el consumo de nutrimentos y el estado nutritivo de 2 tribús africanos (los Ijaw e Isoko), habitantes del área del delta del Río Niger en Nigeria, Africa Occidental, con los métodos empleados en su determinación. Los datos se comparan con los obtenidos de unos ricos comerciantes racialmente semejantes, habitantes del mismo área.

La evidencia sugiere que *ni* los factores genético, climático o parasitario imposibilitan a los indígenos la adquisición de un buen estado de salud y de desarrollo somático, *con tal que* se utilice un aporte adecuado de nutrimentos.

La consideración del aspecto general y del comportamiento de los indígenos y de su nivel de nutrición sugiere que su apatía mental y su irritabilidad estén en relación con una deficiencia prolongada de las vitaminas del complejo B, en particular de la tiamina, y que la ingestión de un amplia cantidad de proteína pueda compensar, en gran parte, esta deficiencia vitamínica A pesar del consumo limitado de vitaminas, no se han visto beriberi, pelagra, ni escorbuto.

El promedio de peso de los Ijaw (pescadores) fué notablemente mayor del de los Isoko (agricultores), atribuyéndose la diferencia a la mayor cantidad de proteína consumida por aquellos.

Se consideran la incidencia y etiología de ciertas lesiones mucocutáneas y de la cirrosis hepática en estos indígenos.

The INDISPENSABILITY *of* FAT *in* PARENTERAL ALIMENTATION *in Dogs*

By H. C. MENG, M.D., PH.D., AND JOHN B. YOUMANS, M.D.

With the technical assistance of WALTER B. CAIN, B.A., AND DOROTHY M. GRIMES, B.A.

IT HAS BECOME more apparent in the last decade that fat, as a dietary component, is an essential nutrient. It furnishes not merely calories which can be replaced by carbohydrate or other energy-furnishing substances, but also provides other essential functions for the animal economy. In the reviews of Burr and Barnes,[1] Deuel,[2] and others,[3-6] the non-caloric functions of fat in the diet are thoroughly discussed. The significance of the accumulated evidence requires no further emphasis.

It is very likely that the effects of fat deficiency are much more serious in sick individuals than in healthy ones. It is well recognized that patients who have fever, trauma, wounds, surgical operations, or other disease conditions require a higher caloric intake and greater amounts of all nutrients. For this reason, it is important to study the essentiality of fat as a component of a parenteral diet for administration exclusively by vein to hospital patients, who cannot or should not eat by mouth.

It has been reported previously[7] by this laboratory that four dogs which received a diet given exclusively by vein and furnishing 80 calories per Kg. of body weight per day for four weeks remained healthy and lively throughout; all animals maintained or gained weight. One other dog was given the same treatment except that the fat was omitted with a reduction of the caloric intake to 53 calories per Kg. of body weight per day. At the end of the 4-week period, the animal had lost 14 per cent of its initial weight, appeared apathetic and emaciated, and showed skin lesions and abnormal hair coating suggestive of an essential fatty acid deficiency. It was felt that the weight loss, skin lesions, and apathy might have been due not only to a comparatively low caloric intake, but also to a deficiency of essential fatty acids. The present study was designed to determine the indispensability of neutral fat and to investigate the possibility of replacing neutral fat with small quantities of essential fatty acids plus glucose in complete parenteral alimentation in dogs receiving isocaloric intakes.

From the Departments of Physiology and Medicine, Vanderbilt University School of Medicine, Nashville, Tennessee.

This investigation was supported in part by a research grant from the Division of Research Grants, National Institutes of Health, U. S. Public Health Service, and in part by the Medical Research and Development Board, Office of the Surgeon General, Department of the Army, Contract No. DA-49-007-MD-252.

EXPERIMENTAL PROCEDURES

In the 3-week control period, five healthy adult male dogs were fed a complete basal diet which furnished 80 calories per Kg. of body weight per day, of which 50 per cent came from carbohydrate, 16 per cent from protein, and 34 per cent from fat. Immediately following this period, one dog (Dog T) was given two mixtures of the nutritional elements containing the same amount of carbohydrate, protein, and fat, but administered by vein. Carbohydrate was supplied in the form of glucose, protein in the form of

Amigen®,* and fat as a 10 per cent olive oil emulsion. This animal served as a control. Two animals (Dogs Br and D) also received the same exclusively parenteral feeding, except that glucose was substituted isocalorically for fat and a supplement of essential fatty acids was given. Methyl linoleate, methyl linolenate, and methyl arachidonate in the amounts of 100 mg., 100 mg., and 10 mg. per Kg. of body weight per day, respectively, were given. The other two dogs (Dogs S and J) received isocaloric parenteral alimentation with neither fat nor essential fatty acids. All five dogs received the same amount of protein, minerals, and vitamins. The essential fatty acids for Dogs Br and D, and fat-soluble vitamins for Dogs Br, D, S, and J were fed by mouth during the parenteral feeding period. The composition of the complete basal diet fed during the control period, the salt and vitamin mixtures and the olive oil emulsion used during the experimental period, and the rate and technique of injection were the same as previously described.[7]

The effects of parenteral alimentation on the general appearance and behavior, body weight, nitrogen balance, "water balance," liver function, total plasma proteins, plasma nonprotein nitrogen, hemogram and urinary sugar and albumin were again determined. The same studies were also carried out for the three weeks prior to the injections. Oral glucose and vitamin A tolerance tests were performed at the end of the 4-week injection period, after which the animals were sacrificed for histologic studies.

The methods for chemical determinations and hematologic study in this experiment were the same as described in the previous communications.[7] "Water balance" refers to the difference between fluid intake and urinary output. Estimation of insensible water loss was not attempted. The glucose tolerance test was carried out by giving 50 Gm. of glucose orally. Samples were drawn for blood sugar before and one-half, one, two, and three hours after glucose administration. Blood sugar was determined by the method of Somogyi-Shaffer-Hartman.[8] Four thousand units of "Navitol®" were fed for the vitamin A tolerance test. Blood was drawn before and 4 hours after the administration of Navitol®." Serum vitamin A† was determined by the method which is based on the principles of the Carr-Price reaction described by Kaser and Stekol.[9]

Results

General Appearance and Behavior

Dog T, which received parenteral alimentation including the fat, remained healthy and lively throughout. Its hair was fine, smooth, and shining. Dogs Br and D, which received only the essential fatty acid supplement, were not as lively and alert as Dog T, but abnormal changes in the appearance of their hair were not observed. Dogs S and J, which received neither fat nor essential fatty acids, appeared apathetic and emaciated. Furthermore, their hair was very coarse, dry and falling out rapidly. The conditions described were clearly demonstrated at the end of the 4-week period of parenteral alimentation.

Body Weight and Nitrogen Balance

Dog T, which received parenteral alimentation with fat, gained 7.6 per cent of its initial body weight during the 4-week period. However, Dogs Br, D, S, and J, receiving the same nutrients without fat, lost 9.2, 4.3, 9.1 and 6.2 per cent, respectively, of their initial weights. Supplementation of essential fatty acids to Dogs Br and D did not prevent weight loss. The nitrogen balance did not show any apparent difference between control Dog T and Dogs S and J during the 4-week period of parenteral alimentation. In no instance was the balance negative, although nitrogen retention was considerably less than it was during the control period. However, Dogs Br and D,

* Amigen®, a protein hydrolysate, was furnished through the courtesy of Dr. Warren M. Cox, Jr., Director of Research, Mead Johnson and Company, Evansville, Indiana.

† Acknowledgment is made to Mrs. Mary Ellen Ferguson and Dr. William J. Darby, Division of Nutrition, Departments of Medicine and Biochemistry, Vanderbilt University School of Medicine, for the determinations of serum vitamin A.

the animals which received essential fatty acids, demonstrated negative balance during the first, second, and fourth weeks of injection. The results are shown in Figure 1.

"Water Balance"

The average "water balance" of the 3-day interval scheme was +809 ml. for Dog T, +814 ml. for Dogs Br and D, and +1004 ml. for Dogs S and J during the control period. The balance was increased in all the three groups of animals during the experimental period. It was +1332 ml., +1310 ml., and +1764 ml. for the respective groups. There was no edema observed at any time during the experimental period in any of the five

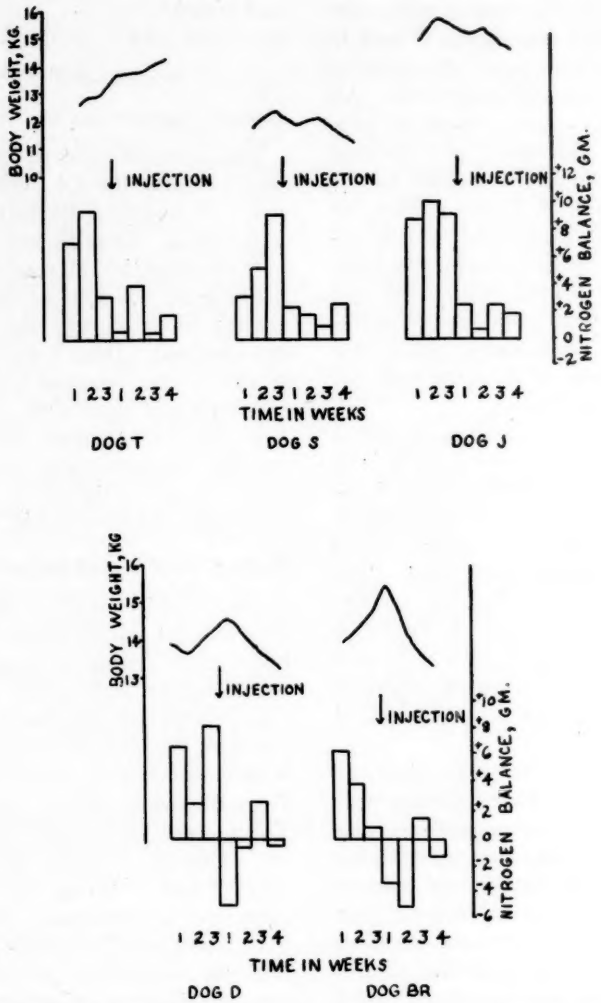

Fig. 1. Nitrogen balance and change in body weight during the control and the parenteral alimentation periods. Dog T received parenteral feeding with fat emulsion. Dogs Br and D received parenteral feeding without fat but with essential fatty acids supplementation. Dogs S and J received parenteral feeding with neither fat nor essential fatty acids.

TABLE I

Summary of the "Water Balance"

Dog	Period	Number of weekly observations	Intake 3-day: Water by mouth (average)	Intake 3-day: Fluid Injected (average)	Intake 3-day: Total (average)	Output of Urine 3-day (average)	Balance 3-day (average)
			ml.	*ml.*	*ml.*	*ml.*	*ml.*
Br	Control	3	2232	—	2232	1710	+ 522
D	Control	3	1687	—	1687	582	+1105
Average for 2 dogs		6	1960	—	1960	1146	+ 814
Br	Exper.	4	3228	2820	6048	4663	+1385
D	Exper.	4	3063	2700	5763	4528	+1235
Average for 2 dogs		8	3145	2760	5905	4595	+1310
S	Control	3	1445	—	1445	620	+ 825
J	Control	3	1595	—	1595	413	+1183
Average for 2 dogs		6	1520	—	1520	516	+1004
S	Exper.	4	1473	2220	3693	2478	+1215
J	Exper.	4	2875	3180	6055	3743	+2313
Average for 2 dogs		8	2174	2700	4874	3110	+1764
T	Control	3	1227	—	1227	418	+ 809
T	Exper.	4	2035	3420	5480	4148	+1332

dogs, regardless of the difference of treatment that they received. The results are presented in Table I.

Blood Chemistry and Liver Function

In no instance was appreciable change in total plasma proteins observed in any of the animals during the experimental period. The plasma nonprotein nitrogen remained within the normal range throughout, except that a slight increase occurred during the second and fourth weeks of injection in Dog J. There was no change in rose bengal clearance in Dog T, but the test was slightly reduced in the other four dogs. Serum alkaline phosphatase was elevated during the second week of injection in Dog T. However, it returned to the control level during the fourth week, despite the continuous daily injection. Rise of serum alkaline phosphatase was also observed in Dogs Br, D, and J, but the same change was not demonstrated in Dog S. The serum alkaline phosphatase determinations made just before the animals were sacrificed, however, showed lower or normal levels in four of the five dogs (Dogs T, Br, D, and S). In the case of Dog J, a further increase was dtmonstrated. The results can be seen in Table II. Neither sugar nor albumin was detected in the urine at any time.

Hematologic Observations

Table III shows the changes in red blood cell count, hemoglobin, hematocrit, and white blood cell count of all the animals during the control and experimental periods, respectively. It can be seen that there was considerable variation in the results. However, statistical analysis* which is not presented here, showed that none of these studies demonstrated any statistically significant change except for an elevation of the white blood cell count observed during the second and third weeks of parenteral alimentation in Dog Br and during the fourth week in Dog J.

Histologic Study†

Gross examination demonstrated no apparent abnormal changes at the end of the 4-

* The authors wish to acknowledge their indebtedness to Dr. Margaret P. Martin, Department of Preventive Medicine, Vanderbilt University School of Medicine, for statistical analysis of the data.

† Acknowledgment is made to Dr. John J. Shapiro, Department of Pathology, Vanderbilt University School of Medicine, for interpretation of the histologic sections.

TABLE II

Effect of Parenteral Alimentation on Liver Function, Total Plasma Proteins and Plasma Non-Protein Nitrogen‡

Dog	Period	Week	Total plasma proteins	Plasma NPN	Rose bengal clearance	Serum alkaline phosphatase*
			Gm. %	*Mg. %*	%	
		1	5.85	32.8	—	3.01
T	Control	2	—	—	85	—
		3	5.72	26.9	82	6.1
		1	—	—	—	—
	Exper.	2	5.23	22.8	83	10.3
		3	—	—	80	—
		4	5.68	28.8	82	6.0, 5.0†
		1	5.69	38.9	99	6.7
Br	Control	2	—	—	—	—
		3	5.58	36.6	107	6.3
		1	—	—	—	—
	Exper.	2	5.54	35.1	89	9.6
		3	—	—	—	—
		4	5.61	29.8	83	15.0, 10.0†
		1	6.19	32.1	108	3.2
D	Control	2	—	—	—	—
		3	6.61	29.9	98	4.0
		1	—	—	—	—
	Exper.	2	5.88	29.8	84	7.2
		3	—	—	—	—
		4	6.59	24.2	83	9.8, 7.1†
		1	7.25	32.5	—	3.2
S	Control	2	—	—	—	—
		3	6.91	24.6	113	2.8
		1	—	—	—	—
	Exper.	2	6.48	21.7	97	4.5
		3	—	—	—	—
		4	6.62	19.3	90	4.8, 4.2†
		1	6.71	33.6	—	3.5
J	Control	2	—	—	—	—
		3	6.07	30.6	91	4.4
		1	—	—	—	—
	Exper.	2	6.45	42.3	86	6.2
		3	—	—	80	—
		4	6.31	43.8	80	10.7, 12.3†

* Bodansky unit per 100 milliliters.

† Just before the animals were sacrificed.

‡ Dog T received fat emulsion; Dogs Br and D received essential fatty acids; Dogs S and J received neither fat nor essential fatty acids.

week period of parenteral alimentation in any of the five dogs. Microscopically, all animals showed various grades of pneumonitis. In the lung sections of Dogs T, D, S, and J, only very low grade changes were observed. The changes in Dog Br were considered moderate. Thickening of the alveolar wall was occasionally seen in the section from Dog T. There was no stainable fat in the lung of Dog Br. In the others, a small amount of fine fat granules was observed in the phagocytic cells (Dogs T, S, and J) and possibly in the capillaries (Dogs D and S). The sections of the liver appeared normal, except that insignifi-

TABLE III

Hematologic Values during the Control and Experimental Periods (See text)*

Dog	Period	R.B.C.	Hb.	Hematocrit	W.B.C.
		Million per cu. mm.	*Gm. %*	*%*	*Per cu. mm.*
T	Control (3 weeks)	6.23	16.7	49.0	8,150
	Exper. (4 weeks)	6.13	15.2	45.8	12,283
Br	Control (3 weeks)	7.32	15.0	42.3	17,583
	Exper. (4 weeks)	6.65	14.0	42.5	25,725
D	Control (3 weeks)	8.27	16.4	50.0	13,817
	Exper. (4 weeks)	7.58	15.3	50.3	15,688
S	Control (3 weeks)	6.41	14.5	24.0	10,053
	Exper. (4 weeks)	6.36	14.8	43.0	10,475
J	Control (3 weeks)	6.43	13.5	39.7	15,017
	Exper. (4 weeks)	5.98	12.6	40.8	23,850

* Dog T received fat emulsion; Dogs Br and D received essential fatty acids; Dogs S and J received neither fat nor essential fatty acids.

cant amounts of fine fat granules were demonstrated in liver cells in all dogs. There was a small amount of sudanophilic material in the convoluted tubules in the kidney sections of all the dogs except Dog Br. The glomeruli appeared normal, and no fat was observed. In the kidney sections stained by hematoxylin and eosin a few casts were demonstrated in the collecting tubules of Dog T, a granuloma in Dog D, dilatation of the tubules in Dog J, and cellular infiltration in Dog Br. Sections of heart, stomach, intestine, spleen, bone marrow, pancreas, testis, thyroid, parathyroid, and adrenal glands showed no abnormal changes. The aortas were normal and no atherosclerotic lesions were observed.

Discussion

The importance of the inclusion of fat in the diet of animals has been recognized. Experimental evidence indicates that fat is as essential a nutrient as protein, carbohydrate, minerals, or vitamins. The effect of different levels of fat in the diets furnishing isocaloric intake on the growth rate of laboratory animals, mainly rats, has been studied by several groups of investigators. Forbes and his associates[10–13] reported that the progressive gains in weight and retention of nitrogen and energy were in the order of the increased fat content in the diets. French, Black, and Swift[14] of the same laboratory further studied the effect of low and high fat diets on growing rats receiving low protein intake. They demonstrated that an increased weight gain, increased body storage of fat and energy, and decreased heat production occurred in animals receiving the ration containing a higher level of fat. Hoagland and Snider[6] also found greater gains in weight in rats fed diets containing various fats at high levels. It has been reported by Deuel *et al.*[15] that rats fed diets containing 20 to 40 per cent cottonseed oil demonstrated better growth and general performance than did those on low fat rations (0, 5, and 10 per cent). In another communication,[16] this group showed that the superior growth of the rats at the high fat levels was the result of actual increase in tissue rather than merely of a deposition of a greater amount of fat. Scheer and his co-workers[17,18] demonstrated that when rats were subjected to severe undernutrition by being fed low caloric rations of different fat levels, mortality was high on a low fat diet and recovery was best with a ration in which a higher percentage of calories was supplied by fat. It is not surprising that in the studies presented in this report, only Dog T, which received parenteral alimentation with fat, gained 7.6 per cent of its initial weight, while Dogs Br, D, S, and J, whose diet lacked fat, lost 9.2, 4.3, 9.1, and 6.2

per cent, respectively, of their initial weights (Fig. 1). It should be pointed out also that all five dogs were healthy and gained weight when fed a basal diet consisting of the same amount of nutrients during the control period.

The results probably would have been more striking if the animals had been starved, traumatized, or diseased for a period of time prior to the parenteral alimentation. Patients who are not able to eat or absorb food not infrequently become severely emaciated and apathetic even if nutrients other than fat are furnished by vein. The supplement of methyl linoleate, methyl linolenate, and methyl arachidonate to Dogs Br and D did not prevent their body weight loss. The failure of the essential fatty acids to prevent weight loss of these dogs which received no fat may be due to (1) inadequate amounts of supplemental fatty acids and/or (2) inefficient intestinal absorption of these acids. In considering the first question, it seems that 100 mg. methyl linoleate, 100 mg. methyl linolenate, and 10 mg. methyl arachidonate per Kg. of body weight per day with a total daily intake of 1.423 Gm., 1.423 Gm., and 0.142 Gm., respectively, for Dog Br, and 1.37 Gm., 1.37 Gm., and 0.137 Gm., respectively, for Dog D would be sufficient. It is possible that the essential fatty acids alone cannot achieve their full effect on promoting growth, but require the presence of some other factor or factors in neutral fat to accomplish such a mission.

As Deuel *et al.*[19] have suggested, the role played by fat in the diet cannot be explained entirely by the essential fatty acids which it supplies, but must be traced to some additional factor or factors. They found that when linoleic acid was given as a supplement to fat-deficient rats, a prompt response in growth resulted. However, the administration of a 10 per cent cottonseed oil diet to rats receiving linoleate at an optimum level resulted in a further acceleration of growth.

In regard to the question of the possibility of poor intestinal absorption of the orally administered fatty acids, the oral glucose and vitamin A tolerance tests were carried out in Dog D at the end of the experimental period. It can be seen from Figures 2 and 3 that both tests were normal. It is reasonable to state, therefore, that the essential fatty acids were absorbed from the intestinal tract and subsequently utilized in the body. Furthermore, the classic pathologic changes of essential fatty acid deficiency, (scaly skin, coarse, dry, and brittle hair, etc.) were not observed in Dogs Br and D. However, Dogs S and J, animals which received neither fat nor fatty acids, showed changes similar to those demonstrated by Evans and Burr,[20–22] Burr and his associates,[23–25] and by Evans and Lepkovsky[26,27] in rats, by Hansen and Wiese[28] in puppies, by Decker *et al.* in mice,[29] and by Meng and Early[7] in dogs receiving parenteral alimentation. This evidence will strengthen the belief that the supplemental fatty acids given to Dogs Br and D were utilized and the change in body weight of the experimental animals was due to the inclusion or exclusion of fat in the parenteral diet.

It is worth while to point out that weight gain in Dog T, which received fat emulsion, was not the only sign showing its superiority over the other animals. It was also lively, alert, and in good spirits throughout, while Dogs Br and D appeared to lack a sense of well-being and alertness, and Dogs S and J were very apathetic. Deuel *et al.*[15] observed that physical capacity is correlated with the fat of the diet. Normal rats which had received the 20 or 40 per cent fat levels were able to swim for the longest period. The greater physical capacity of rats fed on a high fat diet has also been demonstrated by Samuels and co-workers.[30] Some patients who received parenteral alimentation demonstrated a sense of well-being only when fat was given.[31] Burr and Barnes[1] also pointed out earlier that a sudden decrease in the fat content of human diets decreases working capacity and sense of well-being. The mechanism of the effect of fat on physical performance and sense of well-being is obscure. However, it might be postulated that the lipid metabolism of the nervous system might be disturbed or altered without the exogenous supply of some factor or factors in the fat.

Although the nitrogen balance in Dogs Br and D was negative during the first, second,

and fourth weeks of parenteral feeding, and that observed in Dog T was positive throughout, it is reasonable to state that the protein-sparing action of fat was not demonstrated in these studies, since Dogs S and J were positive to approximately the same degree as was Dog T. However, the failure of intravenously administered fat to spare protein, as judged by urinary nitrogen excretion, cannot disprove that fat has been utilized as energy. Furthermore, the experimental evidence of a protein-sparing action of fat is not conclusive. Forbes and Swift[32] showed that the heat production, CO_2 production, and O_2 utilization were increased and urinary nitrogen output was decreased when lard was added to a complete basal diet fed to rats. On the other hand, Rapport[33] found that the output of creatine fell below the starving level on a carbohydrate diet, but rose above it on a fat diet. This strengthens the conclusion reached by Lusk,[34] who demonstrated that urinary nitrogen was reduced when carbohydrate intake was high, while it rose to much higher levels when carbohydrate was replaced by an isocaloric quantity of fat with the same protein intake. Swanson[35] found that when a nitrogen-poor ration is fed to rats, a definite relationship exists between the level of dietary fat and the rate of protein catabolism, providing the caloric intake is reduced to 50 per cent or less of the calculated energy requirement. In the studies reported here, all dogs received 80 calories per Kg. of body weight per day. This may account for the failure to demonstrate the protein-sparing action of fat.

It is of interest to note that the oral glucose tolerance curve of Dog T, which received fat, was similar to that obtained from diabetics, but those of Dogs D and S were normal. It seems difficult to interpret such a change as the result of fat injection. It is true that Gilmore and Samuels[36] have reported that a diaphragm which is taken from a previously

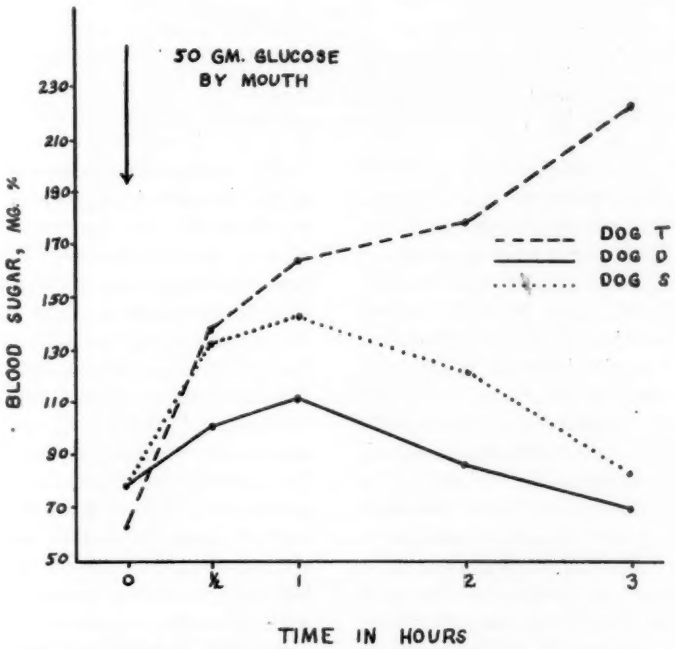

Fig. 2. Oral glucose tolerance curves obtained at the end of the 4-week period of parenteral alimentation. Dog T received fat emulsion. Dog D received no fat emulsion but essential fatty acids were supplemented. Dog S received neither fat nor essential fatty acids.

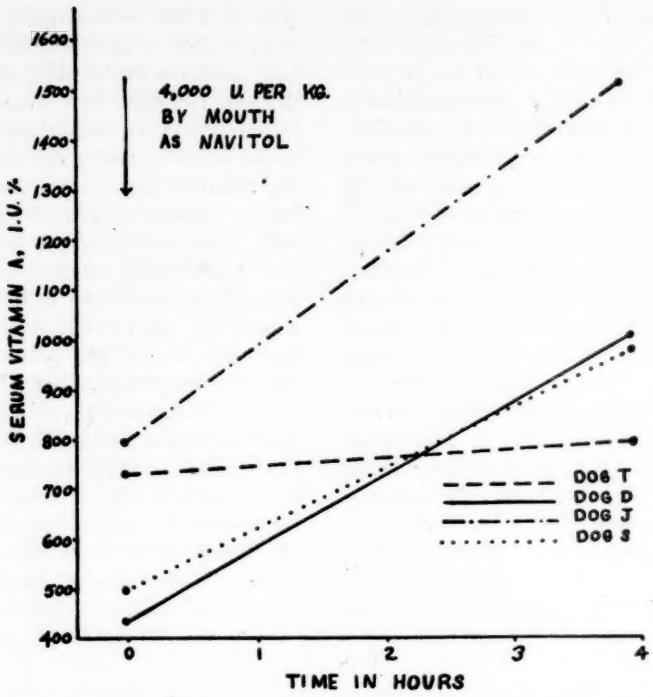

Fig. 3. Vitamin A tolerance curves obtained at the end of the 4-week period of parenteral alimentation. Dog T received fat emulsion. Dog D received no fat emulsion but essential fatty acids were supplemented. Dogs S and J received neither fat emulsion nor essential fatty acids.

fat-fed rat has a very different rate of glucose utilization than one which is obtained from an animal fed with a high carbohydrate diet. Lundback and Stevenson[37] have also demonstrated that the glucose utilization of rat diaphragm proceeds at almost twice the rate in the carbohydrate-fed as in the fat-fed animal. However, Dog T received 39 Gm. of fat daily, which was not particularly high, and it was given 130 Gm. of glucose a day, which could not be considered as carbohydrate deprivation. Furthermore, the urine of Dog T was apparently sugar-free, as was that of the other animals, indicating that the animal was not in a diabetic state. The intestinal absorption of glucose was normal, although the vitamin A tolerance curve in Dog T was flat, suggesting poor absorption. It can be said at this time that a complicated mechanism may be involved and further investigation is required before the observations can be interpreted.

The volume of urinary output was elevated in all animals during the parenteral alimentation period. As interpreted in the previous report,[7] the increase was due to the intravenous administration of a large quantity of fluid plus the increase of water intake by mouth. As a result of increased fluid intake, the apparent retention became more pronounced during the injection period than during the control period (Table I). However, there was no significant difference in water balance among the three groups of animals. The average increase was 64.6, 60.9, and 74.7 per cent for Dog T, Dogs Br and D, and Dogs S and J, respectively. In spite of the increase in water balance, edema was never observed. It seems unlikely that a significant disturbance in any body fluid compartment has occurred at any time during parenteral alimentation, with or without fat.

A reduction of rose bengal clearance (Dogs

Br, D, S, and J) and an elevation of serum alkaline phosphatase (Dogs T, Br, D, and J) were observed during the parenteral alimentation period (Table II). These results strengthen the belief that parenteral alimentation in general would burden the liver whether or not fat is included. The changes in the liver are reversible. However, liver function tests should be carried out when parenteral alimentation is given for a long period of time.

In view of the results shown in Table III, it is difficult to conclude whether or not intravenous administration of fat emulsion *per se* or parenteral alimentation in general caused any significant small changes in the peripheral blood picture. The accuracy and reproducibility of the techniques employed are not great enough. It may be profitable in the future to do tests for hemolysis and fragility. Plasma volume and extracellular fluid space should also be determined.

In view of the histologic findings, it can be stated that intravenous alimentation with or without fat emulsion did not produce any significant damage of the organs examined. The pneumonitis observed in all animals was probably due to respiratory infection which was not related to the experimental procedures. The small amount of fine fat granules seen in the phagocytic cells (Dogs T, S, and J), in the epithelial cells of the bronchi (Dog J), and possibly in the capillaries (Dogs S and D) of lungs, were of no great significance. The significant amount of fine fat granules accumulated in the liver was simply due to the heavy burden which was placed on it by parenteral alimentation. It is not caused by the intravenous administration of fat *per se*, since the animals which received no fat showed a similar change. Sudanophilic materials can be seen in the renal tubules of normal dogs. It appears that the sudan-stained materials demonstrated in the collecting tubules of four of the five animals (Dogs T, D, S, and J) were not the result of pathologic changes due to parenteral alimentation. Furthermore, the nonprotein nitrogen of plasma was within the normal range throughout in all but one animal which showed a slight increase (Dog J). At no time were albuminuria and glycosuria demonstrated. However, interpretations of other changes observed in hematoxylin and eosin sections of the kidney, such as casts in the tubules of Dog T, a granuloma in Dog D, dilatations of tubules of Dog J, and cellular infiltrations in Dog Br cannot be offered at this time. The possible explanation for the absence of glycosuria in the dogs receiving parenteral alimentation was discussed in the previous communication.[7] It might be pointed out that intravenous injection of fat emulsion did not cause the formation of atheromatous lesions.

Summary and Conclusions

One dog maintained for four weeks on complete parenteral alimentation receiving 80 calories per Kg. of body weight per day, of which 34 per cent came from fat, 16 per cent from protein, and 50 per cent from carbohydrate, remained healthy, lively, and in good spirits throughout. It gained 7.6 per cent of its initial weight. Four dogs (Dogs Br, D, S, and J) were given the same treatment except that fat was omitted and an extra amount of glucose was added to make up the calories supplied by fat. Essential fatty acids, including linoleic, linolenic, and arachidonic acids were given as a supplement to two dogs (Dogs Br and D). In spite of the supplement of essential fatty acids they lost 9.2 per cent (Dog Br) and 4.3 per cent (Dog D) of their initial weight. They were not alert and appeared to lack a sense of well-being. The other two dogs (Dogs S and J), which received neither fat nor essential fatty acids, lost 9.1 per cent (Dog S) and 6.2 per cent (Dog J) of their initial weight, appeared emaciated and apathetic, and developed lesions characteristic of essential fatty acid deficiency. The belief that the intravenously administered fat emulsion was utilized was confirmed and further strengthened.

Extensive laboratory tests, which were carried out during the entire period of experimentation, and a complete histologic study following sacrifice, again did not reveal any significant abnormalities attributed to the procedure.

It is concluded that essential fatty acids

can prevent the development of the pathologic changes due to their deficiency but cannot promote body weight gain and preserve a sense of well-being as well as fat.

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Resumen

La indispensabilidad de las grasas en la alimentación parenteral del perro

Un perro mantenido durante un período de 4 semanas con exclusiva alimentación parenteral y recibiendo 80 calorías por kilo de peso por día (de las cuales el 34 por 100 representadas por las grasas, el 16 por 100 por la proteína, y el 50 por 100 por los hidratos de carbono), quedó sano, animado, y de buen humor hasta el final. Ganó el 7.6 por 100 de su peso inicial. Cuatro perros (Perros Br, D, S, y J) fueron sometidos al mismo tratamiento, excepto que las grasas se omitieron y las calorías representadas por las grasas omitidas fueron sustituidas por una cantidad equivalente de glucosa. Los ácidos grasos esenciales, incluso los ácidos linoléico, linolénico y araquidónico, fueron administrados como suplemento a 2 perros (Perros Br y D). A pesar de los ácidos grasos suplementados, estos 2 perros perdieron el 9.2 por 100 (Perro Br) y el 4.3 por 100 de su peso inicial. No estaban animados y parecía les faltase un sentido de bienestar. Los demás 2 perros (Perros S y J), que no recibieron ni grasas ni ácidos grasos esenciales, parecían emaciados y apatéticos y presentaban las lesiones características de una deficiencia de los ácidos grasos esenciales. Quedó pues confirmada y reforzada la opinión de que hubiese sido utilizada la emulsión de grasas administrada.

Extensas experiencias de laboratorio, conducidas durante el curso del período experimental, y un estudio histológico completo después del sacrificio tampoco revelaron ninguna abnormalidad significante que pudiera atribuirse al procedimiento.

Se concluye que los ácidos grasos esenciales pueden impedir el desarrollo de los cambios patológicos debidos a la falta de los mismos, pero que no pueden, tan bien como las grasas, provocar un aumento ponderal ni mantener el sentido de bienestar.

Nutritional Standards, Organization, and Management of SUMMER CAMPS *for* DIABETIC CHILDREN

By HARRY G. JACOBI, M.D.*

With the technical assistance of MILDRED KAUFMAN, B.S., M.S., and TAMI OGATA, A.B., M.S.

THERE CAN be no doubt of the fact that many advantages result from the opportunity afforded a diabetic child to mingle with other children who are similarly handicapped. Among other things, it enables them to get a more wholesome attitude and outlook on their life. These results are quite evident even if the period spent at camp involves only a few weeks. The following observations were gained during the summer of 1951 at Camp NYDA in Burlingham, N. Y., which is operated by The New York Diabetes Association.

While several well-managed camps for diabetic children are now in operation throughout the country, it is our feeling that many more should be organized and operated as a function of the various Diabetes Associations. We are reporting our experiences in the hope that they may be helpful in such future projects.

The success of such an undertaking depends a great deal upon the proper organizational set-up. In order to function most efficiently this must include (1) a well-organized physical program, and (2) an adequate medical regimen. Both these must be integrated in such a way that neither one becomes dominant, but rather are made to complement one another. Our particular organization was arranged so that the responsibility for the overall camp management was entrusted to a Director to whom was delegated the complete supervision of all personnel, both recreational and medical. The Camp Director was in turn directly responsible to the Chairman of the Camp Committee and attempted to carry out the policies and procedures laid down by the various committees of the Association.

* 111 East 80th Street, New York 21, N. Y.
Chairman, Camp Committee N. Y. D. A. Summer 1951.

ORGANIZATION

Briefly stated, the structural set up of Camp NYDA consists essentially of a main administrative building, which also houses the facilities for the preparation and serving of food for the entire camp population. There are several other buildings which house the personnel of the camp, special laboratory buildings, laundries, a special recreation hall building, and an arts and crafts building. The children are housed in newly constructed typical camp-style bungalows, of which there are now seven, each one having accommodations for ten children and two counselors. There is a large lake on the property which has been well equipped for all sorts of waterfront activities. In addition to having one counselor for each five campers, the physical department also included one Head Counselor, three extra Bunk Counselors, one Head Swimming Counselor, and two Specialty Counselors.

The Nutrition Department of the Camp was supervised by two well-trained dietitians who had both completed graduate training in dietetics. There was a chef, an assistant chef, and several kitchen helpers.

The medical supervision of the Camp was entrusted to an Attending Staff, consisting of two physicians serving for each of the three

periods of approximately three weeks each, who were entirely responsible for the medical management of each session. These were selected from the membership of the New York Diabetes Association. There were also two resident physicians in attendance, one for the first half and the other for the greater part of the second half of the summer. Unfortunately, owing to the confusion as regards the military need of physicians and the consequent uncertainty as regards the availability of the young men who were just completing their internships or residencies, this portion of our program was not as well executed as we would have liked, or as well as we were able to accomplish in previous years. It was, however, considered quite adequate and effective.

The Nursing staff consisted of four graduate nurses, with one serving as Supervising Nurse. All these were especially selected because of their previous experience in managing children.

The services of a trained psychologist, who served as a full-time member of the camp staff, was also utilized this summer for the first time, with most gratifying results. This enabled us to obtain a proper evaluation of the personality and social adjustment needs of the individual camper, his particular psychological reactions, and other similar pertinent data which enabled us to furnish either to the referring physician or to the referring agency a carefully worded guidance report on the social and physical behavior pattern of every individual who attended camp. This psychologist acted in the capacity of a regular counselor with a regular assignment of camp duties. Thus he was in an excellent position to observe these children, while they, in turn, were completely unaware that such observations and studies were being made.

Procedure Followed

The children were divided into three groups according to their ages. The first group to go to camp consisted of boys from 15 to 17 years of age, and girls from 14 to 17 years of age. The second group consisted of boys from 10 to 14, and girls from 10 to 12 years. The third or youngest group consisted of boys and girls up to 9 years of age, with the youngest being 6 years. This idea of taking the oldest group first and the youngest last was indeed a very satisfactory one, for by the time the youngest or most difficult group arrived at camp, the routine had been pretty well established and was functioning rather smoothly because most of the kinks had been removed from the established routine and the skill and ease of management of the children, especially by the nursing staff, had likewise progressed.

A preliminary screening of each applicant was done by a special committee of the Association so as to be certain that all the requirements for admission to Camp NYDA were met. These included x-ray of chest, vaccination within previous three years, typhoid-paratyphoid immunization, etc.

An attempt was also made to evaluate the diet and insulin requirements which were to be given each particular camper upon arrival at camp. This has proved to be the most difficult and delicate phase of our entire intake program, for very obvious reasons. These children are referred to us either from Diabetic Clinics or through the recommendation of private physicians. Even those cases who apply independently of these sources actually present the same problem, for each applicant submits information filled in by the physician in charge with respect to the food intake and the dose of insulin being used just prior to going to camp. We have learned from experience to respect this jealously guarded expression of individuality, which is sometimes coupled with manifestations of extreme indignation at the slightest infringement of what the individual physician considers to be his prerogative and professional rights. We have carefully attempted to handle the problem with a certain degree of diplomacy, without, however, sacrificing any of the fundamentals of sound diabetic management. We, of course, have no way of knowing whether the applicant is following the diet as prescribed by his physician, or whether the physician has merely given us some questionable figures based upon his own estimation of what food values he thinks his patient has been consuming. Finally, there are those campers who are referred to us by physicians who believe in

"free" diets, more or less. Our position has been to attempt to regulate these children adequately while they are at camp without causing too much disruption in their previously established routine. Under no circumstances, however, do we permit the child to continue on an unrestricted food intake, but try to fit him into one of the standard diets to be mentioned later. With respect to their insulin administration, however, no attempt is made to switch from one insulin to another, but rather to change the dosage of these as indicated by their degree of glycosuria or insulin reactions. It has been our routine procedure, however, to reduce by approximately 25 to 30 per cent or even more, the amount of total insulin taken by the camper before coming to camp. Experience has taught us that without this precaution, a large percentage of the children go into insulin shock during the first 24 hours at camp.

We adopted, for the sake of expediency, five basic diets which we have found to be quite adequate and practical in meeting almost all the dietary demands of our campers. These are represented in Table I. Additional diets

TABLE I

Diets Used at Camp NYDA

Diet	Carbohydrate	Protein	Fat	Calories
	Gm.	*Gm.*	*Gm.*	
I	160	95	90	1830
II	200	100	100	2100
III	250	110	110	2430
IV	300	120	110	2670
V	325	120	120	2860

requiring a larger total caloric intake have been given wherever the need for such were indicated.

The applicant's record was processed by our committee and based upon the available information, the camper was placed upon that one of the above diets which most nearly corresponded to his physician's diet recommendation. In most cases the variation from the home diet initially was not very great, and this classification meant that instead of having about sixty different diets to prepare at camp, we had only five.

It was realized that good group feeding of diabetics requires careful planning to provide efficient service of attractive, satisfying, and nutritious meals that meet the diet prescriptions of all of the individual diabetics served. As we approached the planning of such diets for a camp group, we felt that the emphasis must be placed upon providing food that was prepared and served much as it would be in a normal camp set-up, with no evidence of a hospital-like routine.

Even before planning actual diets or daily menus, we considered the types of foods which could be used to fit into the diabetic diets and provide maximum nutritive value and appetite appeal at minimum cost. We also had to plan a method of service which would assure that each diet was measured out accurately, yet quickly enough so that hot food was still appetizingly hot, and cold food still cold when served.

Since the diets were planned around the basic protective foods, each child was assured of an adequate daily intake of the essential minerals and vitamins. Children on all diets received at least the following amounts of the basic foods each day.

- 1¼ quarts of milk
- 1 egg
- 5 ounces of meat, fish, or cheese
- 4 servings of fruit, including one or more citrus fruits
- 4 servings of vegetables, including one potato and one or more servings of a leafy green or yellow vegetable
- 1 tablespoon or more of fortified oleomargarine
- 2 or more servings of wholegrain or enriched bread or cereal

According to the basic type diets which are shown in Table I, the menus were planned for each day to provide as much variety as possible from day to day. This was achieved by using many different fruits and vegetables and as many methods of food preparation as would fit into a diabetic diet. By making combinations of food in the same exchange list, or by calculating recipes to combine measured amounts of foods in several exchange lists together, it was possible to serve some mixed dishes not commonly used in diabetic diets.

The diets were served to the children on individual trays which they picked up cafeteria style. The tables were arranged in the same order as the children were numbered in their bunks for their insulin dosage and for urine specimens. The children came into the dining room in this numerical order and so could pick

their trays out of the rack quickly and without confusion.

The figures used for the calculation of the basic dietary allowances were those prepared by the Joint Committee of the American Diabetes Association, the American Dietetic Association and the Diabetes Branch of the United States Public Health Service (Table II).

The following exchange lists were utilized in the making up of our daily diets. These exchange lists include only those foods which were served to children at Camp NYDA, Summer 1951. For the complete exchange lists consult those published by the committees of the American Diabetes Association, American Dietetic Association, and the Diabetes Branch of the United States Public Health Service.

List 1. Milk

Carb.—12 Gm., Protein—8 Gm., Fat—10 Gm., Calories—170

	Measure	*Gm.*
Milk	1/2 pint	240

List 2. Vegetable Exchange

A. These vegetables may be used as desired in ordinary amounts. Carbohydrates and Calories negligible.

Cabbage	Escarole	Radishes
Celery	Lettuce	Spinach
Chicory	Mushrooms	String beans, young
Cucumbers	Peppers	Tomatoes

B. Vegetables: 1 serving = 1/2 cup = 100 Gm.
Carb.—7 Gm., Protein—2 Gm., Calories—36

Beets	Onions	Peas, green
Carrots		

List 3. Fruit Exchanges

	Measure	*Gm.*
Apple	1 small (2" dm.)	80
Applesauce	1/2 cup	100
Apricots, fresh	2 medium	100
Banana	1/2 small	50
Blueberries	2/3 cup	100
Cantaloupe	1/4 (6" dm.)	200
Cherries	10 large	75
Grapefruit and orange juice	1/2 cup	100
Grapes	12	75
Honeydew melon	1/8 (7" dm.)	150
Orange	1 small	100
Orange juice	1/2 cup	100
Peach	1 medium	100
Pear	1 small	100
Pineapple	1/2 cup	80
Pineapple juice	1/3 cup	80
Plums	2 medium	100
Watermelon	1 cup	175

List 4. Bread Exchanges

Carb.—15 Gm., Protein—2 Gm., Calories—68

	Measure	*Gm.*
Bread	1 slice	25
Cereal, dry	3/4 cup	20
Rice, cooked	1/2 cup	100
Spaghetti, noodles, etc., cooked	1/2 cup	100
Crackers		
graham (2 1/2" square)	2	20
saltines	5	20
Vegetables		
Baked beans, no pork	1/4 cup	50
Corn	1/3 cup	80
Potato	1 (2" dm.)	100
Ice cream (omit 2 fat exchanges)	1/2 cup	70

List 5. Meat Exchanges

Protein—7 Gm., Fat—5 Gm., Calories—73

	Measure	*Gm.*
Meat and poultry, (med. fat)		
Beef, pork, veal, chicken, turkey	1 ounce	30
Cold cuts (4 1/2" sq., 1/8" thick)	1 slice	45
Frankfurter	1 (8/lb.)	50
Fish: Cod, haddock, salmon, tuna	1 ounce	30
Cheese, cheddar, American	1 ounce	30
Cottage	1/4 cup	45
Egg	1	50
Peanut butter	2 tbsp.	30

List 6. Fat Exchange

Fat—5 Gm., Calories—45

	Measure	*Gm.*
Butter or margarine	1 tsp.	5
Bacon, crisp	1 slice	10
Cream, light, sour	2 tbsp.	30
French dressing	1 tbsp.	15
Mayonnaise	1 tsp.	5
Peanuts	6 small	10

Foods allowed as desired.
Negligible carbohydrate, protein and fat.

Clear broth	Sucaryl®
Gelatin, unsweetened	Pepper
Lemon	Spices
Mustard	Vinegar
Pickles, unsweetened	

When calculated into type diets the daily meal plans appeared as shown in Table III and the meals were served according to the schedule indicated in this table.

TABLE II

Figures Used for Calculation of Basic Dietary Allowance

Food	Measure	Grams	Carbohydrate	Protein	Fat
Milk	1/2 pint	240	12	8	10
Vegetable exchanges					
Group A	As desired	—	—	—	—
Group B	1/2 cup	100	7	2	—
Fruit exchanges	Varies	—	10	—	—
Bread exchanges	Varies	—	15	2	—
Meat exchanges	1 ounce	30	—	7	5
Fat exchanges	1 teaspoon	5	—	—	5

TABLE III

Type Diets as Served at Camp NYDA, Summer 1951

Food	Measure	Diets				
		I	II	III	IV	V
Breakfast—8 a.m.						
Fruit	Exchange	1	1	1	1	1
Bread (including cereal)	Exchange	1	1 1/2	2 1/2	4	4
Egg (a meat exchange)		1	1	1	2	2
Fat (oleomargarine)	Teaspoon	1	1	2	2	2
Milk	1/2 Pint	1	1	1	1	1
Nourishment—10:30 a.m.						
Fruit juice	Exchange	1	1	1	1	1
Dinner—12 noon						
Meat or fish	Ounces	3	3	3	3	3
Vegetable exchanges						
Group A	As desired	Served family style				
Group B	1/2 Cup serving	1	1	1	1	1
Bread (including potato or other starchy vegetable)	Exchanges	1/2	1 1/2	2	3	3 1/2
Fruit	Exchange	1	1	1	1	1
Fat (oleomargarine)	Teaspoon	1	1	1	1	1
Milk	1/2 Pint	1	1	1	1	1
Nourishment—3:30 p.m.						
Milk	1/2 Pint	1	1	1	1	1
Bread (crackers)	Exchange	1/2	1/2	1	1	1
Supper—6 p.m. (5:30 for 5 to 9 year old group)						
Meat, fish, cheese, or egg	Ounces	2	2	2	2	2
Vegetable exchange						
Group A	As desired	Served family style				
Bread (including potato or other starchy vegetable)	Exchange	1/2	1 1/2	3	3	4
Fat (oleomargarine)	Teaspoon	1	1	2	2	3
Fruit	Exchange	1	1	1	1	1
Milk	1/2 Pint	1	1	1	1	1
*Nourishment—bedtime**						
Milk	1/2 Pint	1	1	1	1	1
Bread	Exchanges	1	1	1	2	2
Meat (peanut butter)	Ounces	1/2	1/2	1/2	1/2	1/2

* Bedtime was at—9:30 p.m. for the 14 to 17 year old group.
8:30 p.m. for the 10 to 13 year old group.
7:30 p.m. for the 5 to 9 year old group.

It will be noted that all children received the same mid-morning feeding. This was done for purposes of practicality during the busy morning hours in the kitchen. This nourishment consisted of four ounces of fruit juice for all campers. (Juices used were orange, pineapple, blended orange and grapefruit, and occasionally tomato juice served with a double saltine.) The mid-afternoon feeding at 3:30 p.m. consisted of a half-pint of milk and crackers, either graham or saltines. The number of crackers varied with the caloric content of the diets, Diets I and II receiving the equivalent of one half-slice of bread and Diets III, IV, and V receiving the equivalent of a whole slice of bread. The final supplementary feeding was given at bedtime. This consisted of one half-pint of milk and one tablespoon of peanut butter for all of the children, with one slice of bread for those on Diets I, II, and III, and two slices of bread for the children on Diets IV and V.

The remaining calories were distributed among the three main meals and varied with each diet. Percentage distribution of calories and carbohydrate in these three meals for the five basic calculated diets is shown in Table IV.

TABLE IV

Distribution of Calories and Carbohydrates in Daily Meals

Diet	Calories			Carbohydrate		
	Breakfast	Dinner	Supper	Breakfast	Dinner	Supper
	%	%	%	%	%	%
I	29.7	37.5	32.7	35.6	35.6	28.9
II	27.8	39.6	32.6	31.7	36.6	31.7
III	29.6	35.1	35.3	32.3	31.7	36.0
IV	34.5	34.3	31.2	36.8	33.2	30.0
V	31.5	34.9	33.5	33.3	33.3	33.3

Measurements were made in household measure as far as possible. Milk was served in half-pint bottles, bread was served by the slice, each slice weighing 25 Gm. Cereals, cooked vegetables, and cottage cheese were measured with one-quarter, one-third, or one-half cup scoops. Fruits were served by the size listed in the exchange list or were cut up and measured by household cup measure. Fruit juices were served in four-ounce glasses. Oleomargarine was cut into five- or ten-gram pats with a standard butter cutter. Meats and American cheese were cut into serving-size pieces and were the only foods weighed on a gram scale. Salads and other Group A vegetables were served on the tables, family style. Such a vegetable was served at each dinner and supper, and we made an effort to provide liberal quantities of salad so that the children could have as much of this as they wished. Plain lettuce and tossed vegetable salads of greens, tomatoes, cucumbers, and radishes were very popular with the children. Another food which was served freely to the children was a thin tomato broth served at supper time when the weather was cold and damp. For Sunday dinner and the farewell masquerade party, a three-and-a-half ounce vanilla "Dixie" cup was calculated into the basic meal plan.

The type diets were planned so that variations in diets were chiefly in size servings of bread and colored oleomargarine. The plates at dinner and supper were all exactly the same except for the size serving of starchy vegetable on Diet I. Since there were few children during the summer who received Diet I, the speed of serving the hot food was greatly facilitated by this plan.

Discussion

The two greatest problems in feeding a group of diabetic children were food refusal because of food dislikes and the dissatisfaction of children on restricted diets who were persistently hungry. When a child completely refused to eat the food served to him, substitutions were made. Cottage cheese or American cheese were substituted for other protein foods, and bread was used for vegetables, fruits, or other carbohydrate foods. Substitutions were made in the initial serving to children who had known allergies or dislikes. Other substitutions were made during the meal by the dietitians who circulated in the dining room while the children were eating. In most instances, substitutions were made only if the child continued to refuse absolutely to touch a certain food until all the other campers at the table had finished eating that particular food.

Unhappiness of children who were persistently hungry and who received less food than others at their table was a real problem. These children were usually appeased by using large quantities of low calorie, low carbohydrate foods so as to make the meals seem as generous as possible, but we noted that often the children did not consider these foods satisfying. It was evident that at home many of the children were allowed extra foods beyond their diets by begging and pleading hunger.

We found that in the case of most of the children—and evidently this was also true of their parents—they had not received adequate diet instructions either from their physicians or from dietitians in the various hospitals or clinics. They had little knowledge of the relative carbohydrate values of food and other exchange values. Several of the girls, for example, honestly felt that they were sticking quite closely to a prescribed diet, but actually were off as much as 1000 calories a day.

As regards the cost analysis of the food consumed by campers at Camp NYDA, an attempt was made to determine, if possible, the cost of such food per person per day. This has been represented schematically in Table V. It

TABLE V

Cost Accounting of Food per Person per Day at Camp NYDA

Food	Cost
Breakfast fruits and juices	$0.068
Cereals, ready to eat	0.010
Bread exchanges	0.027
Vegetable, Group "B"	0.027
Vegetable, Group "A"	0.069
Desserts	0.047
Meat and meat substitutes	0.474
Bread and crackers	0.046
Dairy products	0.354
Condiments and supplementary foods	0.047
	$1.169

will be noted that this amounted to $1.17. Meat and dairy products accounted for the largest share of this cost. It is of interest to point out that once the basic meal plans were determined, the staple food order for the nine-week period was made. This was arrived at by an approximation of amounts and times a certain food item would be used over a week, a three-week, and over a nine-week period. The amounts were determined according to per serving portions, the yield per unit of purchasable commodity, and the total number to be served, which was a hundred.

We feel strongly that it is a mistake to attempt to use these children at camp for any detailed laboratory investigative work. These children come to camp to benefit by the unhampered enjoyment of camp life. They should be permitted to do so and not be subjected to many tests or restrictions which would eventually dampen their enthusiasm for camp life. Besides this, the time which they spend at camp is far too short for any worthwhile laboratory study. However, the obtaining of statistical data carefully collected and evaluated will prove incalculable in aiding us to improve our management of these children. Furthermore, camp projects similar to ours, in order to be successful, must try to the utmost to eliminate or at least conceal as much as is humanly possible, any suggestion of or similarity to the usual institutional medical routine.

Psychological Studies

Our psychological studies that were carried out in this group give an example of how these children lend themselves to thorough and careful observations along certain lines without the individuals being aware of anything. We were very anxious to obtain these studies, primarily for the purpose of supplying the referring physician or clinic with some concrete information regarding the behavior pattern of the diabetic child attending our camp, and also to ascertain whether any noticeable change was observed in this behavior pattern as a result of their experiences and contacts with the other children and with the various members of the camp staff. This was accomplished very effectively by actually assigning to the psychologist the regular duties of a camp counselor, so that these children were each well observed under all conditions and phases of camp life without their being aware of it. The psychologist would also discuss with the other counselors the points to be ob-

served in the campers under their care, and they all maintained a certain uniformity in the pattern and scope of their reports. The results of these studies have given both to us and to the referring physicians and agencies invaluable data and information which has aided us in changing certain of the camp routines, and which we hope will also lead to the marked and much-needed improvement in the psychological behavior pattern of many of these children.

With respect to such psychological evaluations of the individual campers, there were several basic reactions that were included in our analysis. The individual camper's adjustment to camp life was one of our major objectives. We attempted to learn and were particularly anxious to observe such things as his inter-group relationship. Did he manifest any tendency to withdraw from camp activities? What were his chief interests? What was the most outstanding point in his camp adjustment? What was his behavior pattern in general? What were his particular eating habits? What were his social tendencies? What care did the individual camper give to his personal appearance? How did he attempt to adjust himself with respect to his diabetes?

Advantages

The need and value of operating summer camps for diabetic children cannot be stressed too emphatically. It is a function that should be undertaken and adequately developed in each state through the local Diabetes Association. It offers to the diabetic child that much-needed psychological uplift which comes from contact with other diabetic children and the knowledge that they all have common problems. It encourages them to discuss these problems freely and they quickly learn that what loomed paramount as a difficult situation was soon resolved for them into a practical every-day accomplishment. They really "come out of their shell," so to speak, and being thus relieved of their concentration upon what they consider to be their ill fate, they are enabled to devote their energies and thoughts to developing their talents and skills unhampered.

What greater opportunity for field work can one expect to find in public health education as regards diabetes? This can only be accomplished through the effective organization of such camp facilities by the local or regional Diabetes Associations.

In doing this work, great care must be exercised not to destroy or in any way tamper with the jealously guarded prerogative underlying the well-recognized physician-patient relationship. To assure the continued support of the physicians who refer patients to such camps, the objective of management of the diabetic child while at camp should not include the complete change of his previously established routine, but rather should be approached as a practical attempt to modify this routine so that it may be better suited to the needs of the particular child.

Summary and Conclusions

Complete integration and cooperation of the Medical and Physical activities program is essential for successful operation of camps for diabetic children.

Food allowances of most of the campers were arranged under five basic diets which aided materially in the actual serving of the food to a large group of children.

The success of such a camp program depends upon careful preliminary screening of applicants to decide on dietary intake and insulin dosage.

All usual insulin dosage is routinely reduced by approximately 30 per cent for the first 24 to 48 hours of the camp stay.

A well-arranged program of camp activities allowing for sufficient freedom of choice by the individual camper has been found to be most successful.

Cost analysis of daily food consumption at camp per child showed it to be $1.17.

Psychological evaluation studies were attempted for the first time on these children, with rather encouraging results.

Resumen

Standards nutritivos, organización y dirección de los camps *estivales para niños diabéticos*

La integración y cooperación perfectas entre los programas de actividades médicas y físicas son los elementos esenciales en la operación de los *camps* para niños diabéticos.

Las raciones alimenticias para la mayoría de los *campers* fueron arregladas según cinco dietas básicas, lo que facilitó considerablemente el servir de las comidas a un grupo de niños tan grande.

El éxito de este tipo de programa en un *camp* depende de un cuidadoso examen preliminar de los suplicantes, para escoger el régimen apropiado y la dosis de insulina para cada niño.

Durante las primeras 24 a 48 horas de residencia en el *camp* todas las dosis de insulina se reducen automáticamente aproximádamente un 30 por 100.

Un bien arreglado programa de actividades, permitiendo bastante libertad de elección al *camper* individual, ha salido muy bien.

El analisis del precio del consumo diario de alimentos en el *camp* resultó ser $1.17 por niño.

Estudios de valuación psicológica han sido intentadas por primera vez en estos niños, con resultados bastante felices.

Science and the Facts of Life

"It must not be forgotten that men of science can work only if they are paid. They eat, dress, and have families like common mortals. And it so happens that these scientists get on the payroll only when their labors are of interest to somebody, whether it be an individual, an industry, or a government. Now governments, institutions and employers, during the last century of western culture, have been excessively absorbed in the problems of economic exploitation, and have in general shown no great interest in human problems as such. Man was treated as hardly more than an element of production, a cog in the economic machine. That is why there are a great many more paying positions for physicists and chemists than biologists."

—Josué de Castro. *The Geography of Hunger.* Little, Brown & Company, Boston, 1952, p. 300.

THIAMINE METABOLISM *of* WOMEN *on* CONTROLLED DIETS

III. DAILY PYRUVIC ACID VALUES OF WHOLE BLOOD

By BETTY E. HAWTHORNE, M.S., MEI-LING WU, PH.D.,* AND CLARA A. STORVICK, PH.D.

KEYS *et al.*[1] and Foltz, Barborka, and Ivy[2] have found no correlation between thiamine intake and the concentration of pyruvic acid in the blood when their subjects were at rest. Kirk and Chieffi[3] found no relation between fasting blood thiamine levels and fasting blood pyruvate levels in old and middle-aged institutionalized subjects. However, Berryman *et al.*[4] noted an increase in resting pyruvic acid values of blood of subjects receiving a diet deficient in thiamine. It was thought to be of interest to determine pyruvic acid levels in blood as part of a more extensive study of the effects of two levels of thiamine intake on biochemical findings in women on controlled diets.

EXPERIMENTAL

The determination of daily blood thiamine values and the daily urinary excretion of thiamine and creatinine have been reported elsewhere (Dubé *et al.*,[5] and Louhi *et al.*[6]). In these reports values are given which were obtained during the years 1949, 1950, and 1951, in which four, three, and four subjects, respectively, were studied. In 1951 blood pyruvic acid values were also determined for 7 days while the subjects were receiving each day 500 μg. of thiamine per 1000 calories (period 1) and for 14 days while the subjects were receiving 300 μg. per 1000 calories (period 2). Determinations were made by the micromethod of Tsao and Brown.[7] A complete description of the subjects and diets may be found in the report of Louhi *et al.*[6]

RESULTS AND DISCUSSION

In Table I are given the fasting blood pyruvic acid values and fasting blood thiamine values for the last 7 days of each dietary period. It can be seen that for each subject there was an increase in the pyruvic acid content of the blood. (Subject MLW exhibited consistently higher values for pyruvic acid in both periods than did the other subjects.) The average increase for all subjects in period 2 was 11 per cent of the average value for period 1. At the same time, there was a decrease of 11 per cent in the average blood thiamine. Analysis of variance showed that both the rise in pyruvic acid concentration and the fall in thiamine concentration in the blood were significant. It was previously noted (Louhi *et al.*[6]) that these subjects all exhibited a concomitant decrease in the urinary excretion of thiamine.

SUMMARY

Values are reported for pyruvic acid in the blood of four women receiving a controlled diet containing two levels of thiamine intake. There was a rise in pyruvic acid levels and a fall in blood thiamine concentration when thiamine intake was reduced.

From the Nutrition Research Laboratory of the School of Home Economics and the Experiment Station Department of Home Economics, Oregon State College, Corvallis, Oregon.

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* Present address: Department of Pharmacology, Washington University Medical School, St. Louis, Missouri.

TABLE I

Pyruvic Acid and Thiamine Values of Whole Blood

Subject		Mlw	Hal	Cas	Rbd	Mlw	Hal	Cas	Rbd
Thiamine intake	Day of dietary period	Pyruvic acid				Thiamine			
µg./1000 cal.		*Mg./100 ml.*				*µg./100 ml.*			
500	9	—	0.88	0.70	0.74	3.8	3.9	3.9	5.1
	10	1.08	0.68	0.78	0.69	3.1	3.1	3.5	4.5
	11	—	0.77	0.71	0.62	3.9	4.4	4.3	5.5
	12	0.65	0.53	0.50	0.60	3.8	4.1	4.0	5.9
	13	0.90	0.74	0.61	0.61	4.4	3.9	4.7	5.1
	14	0.96	0.76	0.72	0.78	4.0	3.9	5.0	5.3
	15	1.18	0.82	0.63	0.64	—	—	—	—
	Aver.	0.95	0.74	0.66	0.67	3.8	3.9	4.2	5.2
300	8	0.84	0.90	0.68	0.77	3.7	4.3	3.7	4.6
	9	1.01	0.77	0.77	0.82	3.6	3.5	3.7	3.7
	10	0.97	0.75	0.84	0.75	3.7	3.4	3.8	4.1
	11	1.19	0.75	0.86	0.90	3.1	3.5	3.6	4.6
	12	0.84	0.70	0.62	0.74	3.3	3.4	3.7	4.6
	13	1.20	0.77	0.84	0.72	3.2	3.9	3.7	4.3
	14	0.97	0.78	0.90	0.80	4.2	4.0	3.5	4.6
	Aver.	1.00	0.77	0.79	0.79	3.5	3.7	3.7	4.4

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Resumen

Metabolismo de la tiamina de mujeres sometidas a dietas controladas. III. Niveles diarios de ácido pirúvico en sangre total

Se presentan los valores de ácido pirúvico en la sangre de 4 mujeres recibiendo una dieta controlada conteniendo dos niveles de tiamina. Con reducción de la ingestión de tiamina hubo una elevación de los niveles de ácido pirúvico y un descenso de la concentración de tiamina en la sangre.

Editorial

Glucagon—A New Hormone

Glucagon, also known as the hyperglycemic-glycogenolytic factor of the pancreas, is a protein or polypeptide which has just been crystallized by Staub and co-workers at the Lilly Research Laboratories.[1] But that there was a "contaminant" in insulin, which had the effect of transiently elevating the blood sugar, had been known for thirty years. A great deal of interest has centered about this substance recently, but the difficulty in separating glucagon from insulin proved to be a stubborn hurdle. However, the information available to date clearly suggests that this substance will be of clinical significance to physicians in the future.

It appears almost certain that glucagon is a hormone secreted by the alpha cells of the islets of Langerhans in the pancreas. One, if not the major, action of glucagon is to increase the amount of active phosphorylase in the liver. This has the effect of increasing the breakdown of liver glycogen—glycogenolysis—resulting in a rise in blood sugar. There is a possibility that glucagon is controlled by the growth hormone (or the "diabetogenic hormone") of the anterior pituitary. There is also some experimental evidence suggesting that glucagon inhibits glycogen formation under certain conditions and that it has an anti-insulin action.[2] Foa[3] has indicated, by cross-circulation experiments, that glucagon bears a reciprocal relationship to insulin, the secretion of both perhaps being dependent on the blood sugar level. Finally, the actions of glucagon may eventually explain the differences between alloxan and pancreatectomy diabetes—the differences presumably being due to the presence of glucagon in the former, and its absence in the latter.

Clinical studies with relatively purified materials have been limited. By catheterizing the hepatic vein, Myers *et al.*[4] have shown that glucagon promptly produces a rise in the sugar in the blood leaving the liver.

Likewise, glucagon may be part of the explanation of the significant differences between "stable" and "unstable" human diabetes. Kirtley, Waife, and Peck[5] studied the response of blood sugar and serum inorganic phosphorus in various types of diabetic subjects compared to normal persons. The unstable diabetic had almost a normal blood sugar curve and had a normal fall in inorganic phosphorus. That is, in these subjects the presence of glucagon modified the blood sugar and phosphorus reactions resulting in curves which were different from those following simple exogenous glucose as in a tolerance test. The stable diabetic, on the other hand, showed the typical reaction expected in this disorder—a "diabetic type" glucose curve and poor phosphorylation.

It is clear that many questions remain to be answered, and problems solved, before the significance of the "alpha-cell hormone" is fully appreciated. The role of glucagon in the pathogenesis of human diabetes, in insulin-resistance, in spontaneous hypoglycemia, glycogen-storage disease, Kimmelstiel-Wilson syndrome, and other clinical states remains to be discovered.

An ingenious theory, attributed to Bürger,[2] states that normally "alimentary hyperglycemia evokes early discharge of glucagon and

insulin, causing the hepatic reserves of glycogen to be mobilized and stored in the periphery, thus preparing the liver for the uptake of the newly absorbed glucose." Here, then, is the possibility that our knowledge of man's utilization of carbohydrate will be enhanced when we learn more about the "newest" of the hormones—glucagon.

—S. O. WAIFE, M.D.

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Life in a Test Tube?

From time to time there appear articles in scientific journals that stir the imagination, not alone by their scientific ingenuity but by their deeper and more profound philosophical implications. One such brief report (Miller, S. L.: A production of amino acids under possible primitive earth conditions, *Science* 117: 528, May 15, 1953) has the touch of simplicity often found in significant contributions.

It has been suggested previously that the organic compounds "that serve as the basis of life" were formed when the earth had an atmosphere of water, hydrogen, ammonia, and methane—instead of carbon dioxide, nitrogen, oxygen, and water, as it has at present. Since electrical discharge may have also played a significant role in the formation of compounds in the primitive atmosphere, Miller (at the University of Chicago) prepared a simple apparatus which circulated methane, ammonia, hydrogen gases in the presence of water and water vapor past electrodes, which, it was hoped, would form free radicals. Water was boiled, mixed with the gases, circulated past the electrodes, and condensed, to empty back into the boiling flask. It was noted by the end of the week of slow circulation by this method that the aqueous solution became red and turbid. The turbidity was due to colloidal silica from the glass and the red color due to organic compounds absorbed on the silica.

By paper chromatography it was shown that a number of amino acids were now present in the solution. On this basis, glycine alpha-alanine, and beta-alanine were identified. The amino acids were not due to living organisms because growth was prevented by the boiling water during the run and by the presence of certain chemicals such as mercuric chloride, barium hydroxide, and sulfuric acid used during the analysis. It was also noted that it was possible that aspartic acid and various other amino acids, which have not as yet been identified, may have been present in smaller concentration.

As the author mentions, this apparatus was an attempt to duplicate the primitive atmosphere of the earth and not to obtain optimum conditions for the formation of amino acids. Nevertheless, it is conceivable that by modification of this system a higher and different yield of amino acids may be accomplished.

If this finding can be substantiated it will not only open up new fields for research but may present a hint as to those momentous events when the earth was cooling many eons ago, events which led to the development of the greatest enigma of all—life.

Dietotherapy

PLANNING THE HIGH PROTEIN DIET

THERE is overwhelming evidence of the therapeutic role of protein in various clinical situations, in severe undernutrition, following surgery or injury, in diseases of the liver and of the kidney, in infections, and in gastrointestinal disturbances.[1] The maintenance or satisfactory restoration of body protein is accomplished only when careful consideration is given to a number of interrelated factors. Among these are: (a) the level and nutritive efficiency of the protein in the diet; (b) the caloric adequacy of the diet; and (c) the acceptability of the regimen in terms of palatability, national and religious food practices, amount of food, tolerance for a given food or foods, and ability to chew and swallow. The practicability of a regimen is governed by economic factors, such as cost of the food, availability of given foods, and keeping qualities.

QUALITATIVE VARIATIONS IN PROTEIN

The determination of the concentration of the various amino acids in food proteins has established the superiority of animal foods in general as sources of the indispensable amino acids. Thus, the proteins of egg, milk, milk products other than butter, and flesh foods supply efficient mixtures of amino acids to support tissue repletion and growth.

Unfortunately, the great emphasis sometimes placed on the animal sources of protein in therapeutic situations has tended to minimize the valuable contributions which can be made by plant foods in the diet. Most of the cereal foods, nuts, and legumes contain varying amounts of all of the essential amino acids, but one or more of the amino acids usually occurs in concentrations too low to effect tissue building when these foods are used as the sole source of protein. However, if a small quantity of a food rich in the limiting amino acid is used as a supplement with the plant food, satisfactory tissue construction does occur.

Experimental studies have shown that a dietary providing as little as 10 per cent of its protein from milk and 90 per cent from cereal foods has provided an amino acid intake which is excellent for maintenance, and good for growth.[2] While such a ratio may provide satisfactory nutrition in health, clinicians usually recommend that one-half to two-thirds of the total protein intake be supplied from animal foods for the rapid replacement of protein in disease. Whether this practice constitutes extravagant usage is not known at present. Further investigation is certainly indicated to determine the effectiveness of varying proportions of plant and animal proteins in the correction of severe tissue depletion, since community disasters may make it impossible to provide such high proportions or such wide variety of animal foods.

The supplementary relationships of the proteins in plant and animal foods are useful only when the foods are simultaneously fed. In other words, the amino acids amply provided by the cereal foods, for example, cannot be used for the construction of a tissue protein unless the amino acid or acids lacking are likewise supplied then and there from another protein source. Thus, cereal and milk, a sandwich with cheese, egg, or meat filling, or a glass of milk in a meal including legumes provide satisfactory combinations of the essential amino acids. A good rule in meal planning is to include some animal source of protein at each meal. Thus, the costly foods which sometimes may be available in limited quantity may be put to their most effective use when combined with the much less expensive plant foods.

Quantitative Aspects of Planning for Protein

The amount of protein required in many pathologic conditions may be two, three, or even four times as high as that needed for health if recovery is to be assured. Allowances of 150–300 Gm. protein daily have been recommended in conditions such as wound healing, following burns, in diseases of the liver, and in severe undernutrition. These wide variations in protein requirements make it imperative for the physician to specify the approximate level of protein desired when the diet is ordered.

There has been some unjust criticism of the high-protein diets recommended in many texts and diet manuals. Most diets so described provide 110–125 Gm. of protein daily. Time and again such diets have proved to be of unquestioned value in many instances of undernutrition occasioned by previously faulty diet, disturbances of the gastrointestinal tract such as peptic ulcer and colitis, and diseases of the kidney.

The success obtained with the diets of moderately high protein content is dependent on the day-to-day ingestion of the specified quantities of high quality protein foods at caloric levels favorable to efficient use of the amino acids. These diets, as a rule, provide the most desirable base line for planning protein intakes at the higher levels needed in some disease states. They may be modified in terms of flavor, bulk, and consistency for individual needs.

Caloric Intake Affects Protein Requirement

In time of stress the caloric requirements of the body take precedence over other demands, so that carbohydrate, fat, and protein are nonselectively oxidized to provide energy. Thus, the use of high levels of nutritively efficient protein in the dietary is essentially a wasteful procedure unless adequate amounts of carbohydrate and fat are provided simultaneously to supply the needed calories. Far too often high protein foods or proprietary products of limited palatability have been forced upon patients with little regard to the total caloric intake, whereas a more reasonable protein level used in conjunction with a liberal intake of carbohydrate and enough fat for palatability could have resulted in more efficient use of protein.

No precise caloric level can be suggested, since the needs will vary from individual to individual, as well as in different pathologic conditions. In most situations, the requirement is well above that stated for normal individuals under conditions of health. For the adult, it may range from 2500 to 4500 calories, or even higher, depending upon the restlessness of the patient, the elevation of temperature, and the energy required for the process of tissue repletion.

Cereal foods, including breakfast cereals, breads of all kinds, cereal pastes such as macaroni, spaghetti, and noodles, lend themselves especially well to increasing the caloric level of the diet, since they are bland in flavor, easily digested, relatively high in carbohydrate content, and provide acceptable combinations with animal protein foods.

Moderate amounts of sugar, jellies, jams, and syrups may be used in beverages and on breads, but their excessive use may dull the appetite. Glucose, inexpensively available under several trade names, lends itself well for use in beverages, since it is less sweet than sucrose and thus may be used in greater concentrations.

Fats used in moderate quantities are usually desirable because the caloric level of the diet is noticeably increased without the addition of much bulk. The palatability of the diet containing fat is greater than that in regimens severely restricted in fat.

The fat of milk, cream, butter, and egg yolk is well tolerated by most people, while less highly emulsified fats may be unacceptable. Like concentrated sweets, fats must not be used to excess, since they have a high satiety value. A beverage containing considerable proportions of cream taken midmorning or midafternoon may destroy the appetite for the succeeding meal, thus defeating its essential purpose.

Planning Dietaries for Increased Protein Content

The high protein diet should be based on the patient's total nutritional needs, rather than on protein *per se*. It should involve the patient as an individual—his likes and dislikes, tolerance for foods, patterns of eating—and should not impose upon him an alien, unpalatable regimen which may lead to a life-long dislike for essential foods.

A basic pattern for meal planning has been described in an earlier paper.[3] When there are no serious hindrances to the use of a variety of foods, this pattern should be used as the starting point for increasing the protein and caloric intake. One way in which the protein level of this plan may be increased to approximately 125 Gm. daily is indicated below. Approximately 80 per cent of the protein in this diet is supplied from animal sources. It will be noted that the caloric allowance is likewise liberal, and that mineral and vitamin allowances generously exceed those in the Recommended Dietary Allowances for persons in health.[4]

HIGH PROTEIN DIET

Suggested foods	Household measure	Approximate weight	Average protein
		Gm.	*Gm.*
Milk	1 qt.	960	34
Eggs	3	150	18
Meat, poultry or fish	7 oz. (cooked)	210	52
Whole grain or enriched cereal	1/2 cup cooked or 3/4 cup dry	30 (dry)	2
Whole grain or enriched bread	5 slices	150	13
Potato	1 small	100	2
Green or yellow vegetable	1 serving	100	2
Other vegetable	1 serving	100	2
Citrus fruit	1 serving	100	...
Other fruit	1 serving	100	...
Butter or fortified margarine	4 tbs.	60	...
Sugar, sweets	3 tbs.	45	...
			125

Nutritive value of this diet: Calories, 2825; protein, 125 Gm.; fat, 145 Gm.; carbohydrate, 255 Gm.; calcium, 1.6 Gm.; iron, 19 mg.; vitamin A, 13,300 I.U.; thiamine, 1.65 mg.; riboflavin, 3.30 mg.; niacin, 16.2 mg.; ascorbic acid, 130 mg.

Meal Pattern	*Sample Menu*
Breakfast:	
Citrus fruit—1 serving	Orange juice
Cereal—1/2 cup	Oatmeal
Milk for cereal and to drink—1 cup	Milk
Eggs, any style—2	Scrambled eggs
Toast—1 slice	Wholewheat toast
Butter—2 tsp.	Butter; jelly
Beverage	Coffee
Cream—2 tbs.	Cream
Sugar, jelly—1 tbs.	Sugar for coffee and cereal
Lunch or Supper:	
Meat, fish, or poultry—3 oz.	Ground beef patty, large, on buttered bun
Vegetable: green, leafy, or yellow—1 serving	Buttered asparagus tips
Bread—1 slice	
Butter or fortified margarine—3 tsp.	
Fruit—1 serving	Sliced fresh peaches with blueberries and 1/4 cup cottage cheese
Milk—1 cup	Milk
	Peanut butter cookie*
Dinner:	
Meat—3 oz.	Roast veal with currant jelly
Potato—1	Mashed potato
Vegetable—1 serving	Glazed carrots
Bread—1 slice	Hot dinner roll
Butter—3 tsp.	Butter
Milk—1 cup	Milk
Dessert	Chocolate mint pudding*
Beverage	Tea with sugar, lemon
Evening:	
Sandwich	Liverwurst sandwich on wholewheat bread
Bread—2 slices	
Butter—2 tsp.	
Meat, fish, poultry or cheese—1 oz.	
Eggnog	Eggnog, pineapple flavor

* Provide protein and calories in addition to totals listed in column 1.

The suggested meal pattern is only one of numerous ways in which the foods might be arranged. It is well to note that no midmorning and midafternoon feedings are suggested in this plan since it has been found that many patients will have a higher total intake of nutrients if such feedings are not permitted to detract from the customary meals. However, easily digested but substantial feedings in the evening may be used to advantage.

TABLE I

Nutrient Values of Foods Containing Approximately Equivalent Amounts of Protein*

Food	Household measure	Weight	Calories	Protein	Fat	Carbohydrate	Calcium	Iron	Vitamins				
									A I.U.	Thiamine	Riboflavin	Niacin	Ascorbic acid
		Gm.		*Gm.*	*Gm.*	*Gm.*	*Mg.*	*Mg.*	*I.U.*	*Mg.*	*Mg.*	*Mg.*	*Mg.*
Milk, fresh	1 cup	244	165	9	10	12	288	0.2	390	0.09	0.42	0.3	3
Milk, evaporated	1/2 cup	126	175	9	10	13	306	0.2	505	0.06	0.45	0.3	1
Milk, fermented (Yogurt)	5/8 cup	140	130	9	5	13	320	..	180	0.09	0.05	...	2
Milk, nonfat solids	3 tbs.	23	85	8	Tr.	12	299	0.1	9	0.08	0.45	0.3	2
Cheese, cheddar	1 oz.	30	120	8	10	1	217	0.3	420	0.01	0.13	Tr.	0
Cheese, cottage	3 tbs.	42	40	8	Tr.	1	40	0.1	8	0.01	0.12	Tr.	0
Egg, whole	1 medium	54	80	6	6	..	26	1.3	550	0.05	0.14	Tr.	0
Egg white	2	62	30	7	0	..	4	0.2	0	0	0.16	Tr.	0
Beef, hamburg	1 oz.	30	120	7	9	0	3	0.8	0	0.02	0.06	1.4	0
Beef, round, cooked	1 oz.	30	70	8	4	0	3	1.0	0	0.02	0.07	1.7	0
Beef, strained	1 1/2 oz.	45	45	8	2	0	4	1.9	0	0.01	0.12	1.5	0
Lamb chop, cooked	1 oz.	30	125	7	11	0	3	0.9	0	0.04	0.08	1.7	0
Lamb, leg, cooked	1 oz.	30	80	7	6	0	3	0.9	0	0.04	0.08	1.5	0
Liver, beef, cooked	1 oz.	30	65	7	3	3	5	2.4	16,050	0.08	1.19	4.5	10
Liver, strained, infant	1 1/2 oz.	45	45	7	2	1	10	3.0	8,160	0.02	0.92	2.7	0
Pork, ham, cooked	1 oz.	30	110	7	9	0	4	0.9	0	0.19	0.07	1.4	0
Chicken, cooked	1 oz.	30	60	9	2	0	4	0.5	0	0.01	0.05	1.9	0
Fish, med. fat, cooked	1 oz.	30	45	7	2	0	4	0.3	24	0.02	0.02	2.4	0
Bread, white, enriched	3 slices	90	240	8	3	45	30	0.6	0	0.06	0.06	0.9	0
Beans, baked	1/3 cup	130	150	8	3	24	53	2.4	110	0.06	0.05	0.6	3
Peanut butter	2 tbs.	30	180	8	14	6	20	0.6	0	0.08	0.04	4.6	0
Soybeans	1/3 cup, cooked	20 (dry)	70	8	3	3	47	1.6	24	0.21	0.06	0.4	0
Yeast, brewer's	5 tsp.	18	65	9	Tr.	7	14	3.6	0	2.93	0.72	7.2	0

* Protein, fat, carbohydrate have been rounded off to the nearest whole gram; calories have been rounded off to the nearest 5.

Supplementation of the High Protein Diet

Even the liberal diet outlined above will be inadequate to meet the protein and caloric needs of some individuals. Extremely high levels of intake are difficult to achieve unless one resorts to the use of concentrated foods of high protein content and can persuade the patient to consume the foods from day to day. Table I lists a variety of foods in amounts which are interchangeable with respect to their protein value. Other nutrient values are also given, since considerable variations in the diet may occur depending upon the substitutions which may be used. For example, hard cheeses contain only one-third as much riboflavin as milk supplying the same amount of protein; cottage cheese is not comparable to milk as a source of calcium; and flesh foods are negligible in their calcium content.

Skim milk powder, for a number of reasons, is ideal for supplementing the protein content of the diet: (a) the quality of the protein is superior; (b) its high protein concentration makes it possible to increase greatly the protein level of the diet without a material increase in the bulk content of the diet; (c) its bland flavor makes it readily acceptable to most individuals and permits its use in a variety of ways; (d) the tolerance and digestibility quotients are high; (e) the cost is far less than that of other foods which provide equivalent protein (see Table II); (f) the keeping qualities are excellent; and (g) it is readily transported and stored with minimum space requirements. A number of more costly proprietary products recommended by physicians for protein supplementation incorporate skim milk powder as a primary constituent.

The following beverages employing skim milk powder provide palatable nourishments of high protein concentration.

High Protein Milk

1 cup skim milk powder
1 quart whole milk

Sprinkle milk powder on top of milk. Beat with rotary beater until smooth. Chill thoroughly before serving.

Flavor variations: Add 1–2 tablespoons chocolate syrup.

Protein content: 16 Gm. per cup (8 fluid ounces).

High Protein Eggnog

(1¼ Quarts)

4 eggs
1–2 tablespoons sugar
1 quart whole milk
1 cup skim milk powder

Beat eggs with sugar. Add milk and mix. Sprinkle milk powder over milk-egg mixture and beat until smooth. Flavor with vanilla and nutmeg as desired. Chill thoroughly before serving.

Protein: 19 Gm. per cup (8 fluid ounces).

While greater amounts of milk solids have sometimes been used in the above beverages, the consistency tends to become viscous and the acceptance by the patient is decreased. Whenever low fat regimens are required, the above beverages may be prepared using twice the recommended amounts of powdered skim milk and substituting water for the whole milk. Such beverages are less palatable than those made with whole milk.

Strained meat as canned for infant use is a welcome addition to the liquid diet which must be increased in its protein content. When diluted with broth or bouillon, strained beef or veal provide especially acceptable soups. Most patients are unable to take strained meat in amounts which will give protein levels comparable to those achieved with milk and milk solids. Moreover, the cost is relatively high (see Table II).

Cost Considerations

Individuals in the home as well as the dietary departments in hospitals are usually cost conscious. To recommend costly foods to people unable to buy them is admitting defeat. Table II gives a comparison of the costs of equivalent amounts of protein from various food sources. At the time of this writing the prices of beef and veal are considerably lower than those of preceding months, while pork prices are somewhat higher. Although some cuts of beef and veal provide relatively inexpensive sources of protein, it will be noted that meats with a relatively high proportion of waste—e.g., chops, steak, chicken—attain the status of luxury items. The protein from yogurt, widely publicized in lay publications, costs approximately half again as much as

TABLE II

Comparative Costs of Equivalent Amounts of Protein from Natural Foods

Food	Food cost per pound as purchased*	Protein content per pound of food†	Cost of 100 Gm. Protein
		Gm.	
ANIMAL SOURCES			
Milk, non-fat solids	$0.32	162	$0.20
Cheese, cottage	0.29	89	0.32
Liver, beef	0.39	89	0.44
Hamburg	0.37	73	0.47
Veal shoulder	0.35	70	0.50
Cheese, cheddar	0.59	114	0.52
Veal leg	0.49	84	0.58
Haddock fillet	0.49	82	0.60
Beef, boneless rolled roast	0.53	84	0.63
Milk, whole, 3.25% fat	0.24 (per qt.)	34 (per qt.)	0.71
Salmon, red, canned	0.65	92	0.71
Tuna, canned	0.86	108	0.79
Frankfurter	0.55	65	0.85
Lamb, leg	0.59	68	0.86
Chicken, dressed, fryer	0.49	51	0.96
Beef, roundsteak, boneless	0.87	89	0.98
Egg, medium size, grade A	0.81	73	1.11
Ham, smoked	0.75	67	1.12
Yogurt	0.32	28	1.14
Beef, chipped	1.80	156	1.16
Beef, porterhouse steak	0.75	64	1.17
Meat, strained for infants (beef, veal, pork, lamb, or liver)	1.01	76	1.33
Pork chops, loin	0.89	60	1.48
Lamb chop, rib	0.89	51	1.74
Ice cream	0.60	18	3.33
PLANT SOURCES			
Navy beans, dry	0.14	97	0.15
Oatmeal	0.12	65	0.18
Peanuts	0.35	88	0.40
Peanut butter	0.49	119	0.41
Bread, white, 4% milk solids	0.18	39	0.46
Wheat cereal, ready-to-eat	0.30	49	0.60
Rice	0.24	35	0.70
Yeast, brewer's	1.30	168	0.80

* Supermarket prices as of July 10, 1953.

† Protein content on basis of food as purchased.

that of fresh whole milk and more than five times as much as that from non-fat milk solids. No significant difference in nutritional value of various fermented milks, including yogurt, has been observed.

SUMMARY

Factors which affect the planning of the high protein diet include the nutritive efficiency of the protein, the amount of protein necessary in various pathologic conditions, the calorie level of the diet, and the patient's acceptance of the diet.

A plan has been presented for a diet containing 125 Gm. protein and approximately 2800 calories. Consideration has been given to the choice of supplementary foods to further increase the protein content of this diet, or to provide substitutes for foods in the suggested list. Skim milk powder is, in most instances, by far the best food for enhancing the protein content of the diet.

The cost of protein from various food sources has been compared.

A high protein, high calorie diet of natural foods can be planned to meet the requirements of most individuals in terms of total nutrient needs, consistency of foods, amount of bulk, and acceptability. When such diets are prepared with every regard for eye and taste appeal and presented to the patient as an important part of his therapy, there can be a markedly reduced need for expensive, unbalanced, and unpalatable feedings whether taken orally or by tube.—CORINNE H. ROBINSON.

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Nutrition News

☆ News of activities in the field of clinical nutrition should be submitted to the Editorial Office of the JOURNAL.

PAUL H. BELDING

We announce with great regret the death of Paul H. Belding, D.D.S., a member of the Advisory Editorial Board of this JOURNAL, and the well-known editor of that unique publication, *Dental Items of Interest,* the oldest dental magazine of continuous publication in the world.

ROBERT M. KARK

Dr. Robert M. Kark, a member of this JOURNAL's Editorial Board, has been elected a Fellow of the Royal College of Physicians of London. Dr. Kark is also a Fellow of the American College of Physicians, and Professor of Medicine at the University of Illinois.

AMERICAN SOCIETY FOR THE STUDY OF ARTERIOSCLEROSIS

The Seventh Annual Meeting of the American Society for the Study of Arteriosclerosis will be held on November 1 and 2, 1953, at the Hotel Knickerbocker in Chicago. Among the 35 clinical and experimental papers dealing with atherosclerosis and all its ramifications are the following which may be of particular interest to our readers:

The Association Between the Habitual Diet and the Incidence of Degenerative Heart Disease in Different Populations—Dr. A. Keys.

Obesity and Serum Lipids—Drs. Pomeranze, Lucarello, and Goldbloom.

Lipoprotein Studies on Humans Subjected to Controlled Dietary Regimens with Subtraction and Addition of Fats, Sitosterols and Dihydrocholesterol—Drs. Boyle, Wilkinson, Jackson, and Benjamin.

Squalene Feeding in Experimental Atherosclerosis—Dr. Kritchevsky and associates.

The Effect of Varying the Intake of Dietary Fat and the Ingestion of Sitosterol on the Lipid Fractions of Human Serum. Dr. Wilkinson and co-workers.

MILK INSTITUTE

"Homogenized Vitamin D Milk and Human Health—An Appraisal of Present Knowledge and Future Possibilities" will be the subject of a one-day Institute to be held at the Barclay Hotel in Philadelphia on Friday, October 23, 1953, under the auspices of the Milk Research Laboratory of the Children's Hospital of Philadelphia, which commemorates a quarter-century of activity in the milk field this year.

Among the speakers and their topics are:

The Child Drinks Milk. Physiologic Concepts of Digestion—Dr. Irving J. Wolman, The Milk Research Laboratory of The Children's Hospital of Philadelphia.

A Quart of Milk a Day. Cow's Milk as a Source of Childhood Nutrition—Dr. James R. Wilson, Secretary, The Council on Foods and Nutrition of the American Medical Association.

The Disappearance of Rickets. Vitamin D Milk as Related to Mineral Nutrition—Dr. Harold Edward Harrison, Pediatrician-in-Chief, Baltimore City Hospital, Baltimore, Md.

Improving the Nutritional Quality of Cow's Milk—Recent Advances and New Directions—Dr. Conrad A. Elvehjem, Chairman, Department of Biochemistry, University of Wisconsin, Madison, Wis.

DIETITIAN WANTED

The Office of the Surgeon General announces a vacancy for a staff dietician for service in Japan. The salary is $3410 per year, with a 10 per cent increase when tour of duty begins in Japan (two-year minimum duration of service). For further information write:

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Reviews of Recent Books

Phosphorus Metabolism. A Symposium on the Role of Phosphorus in the Metabolism of Plants and Animals. Volume II, edited by William D. McElroy and Bentley Glass, The Johns Hopkins Press, Baltimore, 1952, pp. 930, $11.00.

The papers and discussions presented at the second Symposium on Phosphorus Metabolism held at The Johns Hopkins University in June 1952 are published in this volume. The subjects include aspects of phosphorus metabolism not covered in the first Symposium. The major headings are: mechanisms of phosphate assimilation, under which are discussed acid-soluble phosphates in both animal and plant metabolism; the role of phosphate in amino acid and protein metabolism and in metabolism of lipids; the chemistry and metabolism of nucleic acids; the role of phosphate in the metabolism of photosynthetic and chemoautotrophic organisms; the influence of hormones on phosphate metabolism; and phosphate metabolism in specialized tissues.

A total of 41 papers is included, with an 89-page summary by Dr. Glass. The papers consist of reviews ranging in length from three to forty pages by writers whose authority has been established by important contributions to the field discussed. The emphasis is on current work, and in many of the subjects covered activity is so intense that a summing-up and integration is indeed a welcome aid to the many workers who must acquire and maintain a thorough knowledge of the developments in these important areas. Throughout the volume, a substantial amount of unpublished work is included. Discussions from the floor add to the interest of the presentations and often provide insight concerning the implications and new directions of thought.

Those interested in nutrition and growth will find much included that directly applies to these fields. There are, for example, papers dealing with recent developments in the chemistry and biosynthesis of nucleic acids. The discussion of the relationships between synthetic reactions, glycolysis, and respiration in cancer tissue provides insight into similar regulations in normal tissues. The description of the ingenious and plausible hypothesis proposed by Ling to explain resting potential of muscle and its accumulation of specific ions by a process of selective adsorption dependent on the chemical state of the muscle proteins suggests numerous other applications of the same line of reasoning.

Those concerned with clinical aspects of nutrition also will find much of direct interest in the reviews of bone metabolism, in those dealing with effects of parathyroid, thyroid, pancreatic (including the hyperglycemic factor), adrenal, and pituitary hormones on phosphorus metabolism, and in many others. However, in addition to its contribution to specific fields, the volume provides an astonishing amount of general information concerning metabolism that will make it a useful source of information for some years to come.

In a book as valuable as this, presenting such a large fund of information, a more comprehensive index would have been desirable. J.G.R.

Progress in the Chemistry of Fats and Other Lipids. Volume I, edited by R. T. Holman, W. O. Lundberg, and T. Malkin, Academic Press, New York, 1952, pp. 186, $7.00.

This book is a critical and up-to-date survey of the subject and consists of five sections each covering a particular phase of lipid chemistry. All sections are well and authoritatively written and should be of interest to those concerned with the chemistry of the fats and lipids.

The first section, "The Molecular Structure and Polymorphism of Fatty Acids and Their Derivatives" by T. Malkin of the University of Bristol, is concerned primarily with methodology and interpretation of data. An excellent discussion of the meaning and interpretation of the x-ray data of fatty acids, the related esters and hydrocarbons is included. Polymorphism of fatty acids and their ethyl esters is also discussed.

Werner Bergmann of Yale has presented a well-written section on "Sterols." Included are properties of the individual sterols, methods for isolation, sources of material, and a great deal of characterization data. In addition, there is a section concerning the conversion of sterols to vitamin D. Other steroids are not discussed. This section should be a valuable aid to those interested in obtaining an overall picture of the chemistry of sterols.

The section on the "Structure and Properties of Phosphatides" by P. Desnuelle of the University of Marseille is adequate in that it covers very well the lecithin, cephalin, and inositol lipids, together with some information about the sphingolipids. However, it does not mention the use of glacial acetic acid for fractionation of the soybean lipids, as published by Carter.

Ralph T. Holman of the Hormel Institute has reviewed the recent progress in the chromatography of

lipids and has included sufficient background information to acquaint the non-expert reader with the general problems in the field. Included are discussions and results of elution analysis, frontal analysis, displacement analysis, and partition chromatography as applied to the field of fatty acids and related products.

In the final section, H. J. Harwood of Armour and Company has presented a very excellent discussion of fatty acid derivatives. Included are amides, amines and alkylammonium compounds, nitriles, hydrazines and hydrazonium salts, isocyanates, acid chlorides, acid anhydrides, aldehydes, ketones, and derivatives of the hydrocarbon chain. The discussion largely concerns the higher fatty acids.

One of the outstanding features of this book is the large number of references. As a whole, the book accomplishes its purpose and should be a welcome addition to the field of lipid chemistry. M. H. McC.

Biochemistry and Human Metabolism by Burnham S. Walker, William C. Boyd, and Isaac Asimov. Williams and Wilkins Co., Baltimore, 1952, pp. 812, $9.00.

The plan of presentation and the organization of the subject matter in this textbook represent the modern point of view in the teaching of biological chemistry. The *dynamic concept* of biochemistry is gradually replacing the classical *static* approach. The book is divided into the five major categories of the chemistry of the living organism: structure, control, growth, metabolism, and pathology.

The emphasis in the section on structure is on the chemistry of the proteins, with a very excellent review of the modern methods of protein chemistry and the nature of the protein molecule. Of special interest is the chapter on tissue chemistry which reviews the existing knowledge of the biochemistry of connective and supporting tissue, skin and its appendages, adipose tissue, muscle and muscle contraction, nerve tissue, and sense perception. These subjects are generally neglected in biochemistry courses although manifestations of disease and mechanisms of drug action are usually reflected by alterations in these tissues. In no instance are biochemical fundamentals sacrificed for elaborate reviews of spectacular recent developments.

The incorporation of the chapters on enzymes and hormones into a section entitled *Control* integrates the factors which catalyze single biochemical reactions or which regulate complete patterns of metabolic processes into a unit. Thus the phenomena of control and biological organization on a chemical basis are given positions of fundamental importance. Further support is given to the concept of integrated biochemical control by including a chapter titled "Hormone-Enzyme Relationships." Although the authors cite several well-known examples of interrelationship, they conclude that "the few glimmers of light, that are now beginning to appear, while interesting and hopeful, are far from sufficient to illuminate even a corner of the subject."

The section on growth includes chapters on the chemistry of nucleoproteins, cancer, reproduction, and heredity. Although discussions of the chemistry of cancer, reproduction, and heredity have usually been relegated to advanced courses in biochemistry, an understanding of the fundamental cellular chemistry involved here would permit a fuller appreciation of these subjects when considered later in medical studies and practice. The authors have presented the chemistry of cancer as an alteration or breakdown in cellular chemical organization. The discussion of heredity emphasizes the chemical mechanism of cell division and the chemical nature of the blood group substances.

Beginning with the section on metabolism, the authors have correlated the normal metabolic processes with well-known pathologic alterations in metabolism. In this way, by demonstrating the biochemical defect in certain more common metabolic pathologies, they have emphasized the clinical significance of fundamental biochemistry. The subjects discussed are: Carbohydrates and Diabetes, Lipid Metabolism and Ketosis, Proteins and Starvation, Electrolytes and Water, Edema and Shock, and finally, Respiration and Acidosis. In addition, in the chapter on Food and Diet, the biochemical aspects of malnutrition and food requirements are introduced. The early introduction of nutrition into the medical curriculum is important because too often this vital phase of medicine is overlooked or only briefly surveyed during the clinical years. It also provides the student with a more integrated view of the nutritional and physiological well-being of the patient.

The last section, pathology, in addition to a chapter on vitamins furnishes the student with a brief introduction to the concepts of immunochemical specificity and metabolite antagonism. Here again a biochemical foundation is constructed upon which to develop ideas in pathology, pharmacology, and medicine.

This book has been written for medical students but is highly recommended to all physicians who wish to review fundamental biochemistry in its application to medicine. CARL ALPER

Food Science, edited by E. C. Bate-Smith and T. N. Morris, Cambridge University Press, London and New York, 1952, pp. 319, $8.00.

Food Science is a collection of lectures by authorities in each of the subjects covered. The various topics are not all equally treated because the lectures were given in a summer course in food science arranged by the University of Cambridge.

The chapter on foods in the United Kingdom is not limited to that area. It presents a challenge to all food technologists. The possibility of enlarging

our sources of food supplies through knowledge of technology makes the reading of this section instructive. The principal foodstuffs, including meat, fish, eggs, fresh fruits and vegetables, and cereals, are discussed, and the information included will spare long hours of work uncovering recent research.

Spoilage of foods is dealt with from the point of view of chemical and biological mechanisms. The preservation of food is covered in another chapter. Recent research on the destruction of protein and vitamin content during the various processing procedures have not been overlooked. The chapter on micro-organisms as sources of protein and fat is one of growing interest, and reports of work done during the last war when food shortages were being experienced are most interesting. The illustrations include 16 plates which are unusually helpful.

The book is a valuable addition to the literature, since there are not many of its kind to be found. This symposium on quality and preservation of food should prove a most valuable up-to-date reference book not only for the food technologist but also for the dietitian and nutritionist. The title, *Food Science*, was carefully chosen, for the subject is presented in a broad way which will interest those engaged in other fields of science. S.M.B.

Freezing and Drying edited by R. J. C. Harris, Hafner Publishing Co., New York, 1952, pp. 206, $3.00.

This monograph is a very complete collection of data presented at a symposium, held under the auspices of the Institute of Biology, on the industrial applications of freeze drying of biological materials and the design of equipment. It consists of 19 reports presented at 4 sessions by eminent workers in the field.

The first session describes the equipment used in the manufacture of blood products, other parenteral biologicals, and food products. The fundamental aspects of the design of freeze drying equipment and the criteria for satisfactory drying with respect to vacuum and temperature requirements are discussed.

The second session is devoted to the application of low temperatures and freeze drying procedures to the preservation of mammalian cells and tissues. The viability of tissues after treatment is a function of the rates of freezing and thawing, the degree of desiccation, and the duration of freezing. Slow freezing is found to be more desirable than rapid freezing for survival of certain tissues. In rapid freezing there is danger of vitrification, which results in tissue damage.

The third session presents a discussion of the freeze drying of bacteria, viruses, and antisera. The viability of bacteria after treatment depends, particularly, upon the presence of a protective colloid and reducing substances in the suspending medium, and also on the degree of desiccation and absence of oxygen. Since the methods do not work equally well for all organisms, a routine procedure has not been defined.

The fourth session describes experiments on tissue fixation by freeze drying. The advantages of this procedure over the chemical method are that there is no appreciable immediate protein denaturation; dissolution effects by organic solvents with consequent loss of tissue are avoided; and cytoplasmic constituents are preserved and not translocated. This procedure is especially desirable in the preparation of tissues for electron microscopy and cytochemical analyses.

The freeze drying technique is being applied more frequently in tissue laboratories for research and diagnostic purposes, in the food industry, and in the manufacture of biologicals. This monograph provides an introduction to this important new development in biological technology. CARL ALPER

Books received for review by the *Journal of Clinical Nutrition* are acknowledged in this column. As far as practicable, those of special interest are selected, as space permits, for a more extensive review.

Year Book of Endocrinology, 1952, edited by G. S. Gordon, The Year Book Publishers, Chicago, 1953, pp. 400, $5.50.

Annual Review of Medicine, Volume 4, edited by W. C. Cutting and H. W. Newman, Annual Reviews, Inc., Stanford, 1953, pp. 452, $6.00.

Advances in Food Research, Volume IV, edited by E. M. Mrak and G. F. Stewart, Academic Press Inc., New York, 1953, pp. 457, $9.00.

Essentials of Physiological Chemistry (fourth edition) by A. K. Anderson, John Wiley & Sons, Inc., New York, 1953, pp. 480, $5.00.

Handbook of Dietetics for Nurses by C. F. Harris, Ballière, Tindall & Cox, London, and The Williams & Wilkins Co., Baltimore, 1953, pp. 196, $4.00.

Refining of Oils and Fats for Edible Purposes by A. J. C. Andersen, Academic Press Inc., New York, pp. 204, $7.00.

Holt Pediatrics (twelfth edition) by L. Emmett Holt, Jr., and R. McIntosh, Appleton-Century-Crofts, Inc., New York, 1953, pp. 1485, $15.00.

Abstracts of Current Literature

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POTASSIUM AND THE HEART

The role of potassium in supporting protein metabolism, cellular metabolic activity, growth, and other vital functions, is established. In deficiency states involving potassium, degenerative changes have been found in the myocardium and in the kidneys. Additional studies have led to the detection of similar lesions in skeletal muscle and epiphyseal cartilages.

Lesions of Epiphyseal Cartilage and Skeletal Muscle in Rats on a Diet Deficient in Potassium. J. Cohen, R. Schwartz, W. M. Wallace. *Arch. Path.* 54: 119, 1952.

In 1942 Follis, Orent-Keiles, and McCollum demonstrated that the most important pathologic lesions induced by K-deficient diets in rats were necrosis of myocardium and renal tubular changes. No changes in skeletal muscle or epiphyseal cartilage were found. One might have suspected changes in epiphyseal centers of growth since the growth of rats was retarded on such diets. One might also be disappointed to find no morphologic reflection of the marked reduction of the normal K level in muscle in rats on such diets.

The original plan of Cohen *et al.* was to study in weanling rats the repair sequences after K deficiency, with particular pathologic emphasis on cardiac muscle. The unexpected detection of lesions of skeletal muscle and epiphyseal cartilage were major new findings.

The skeletal muscle changes were usually microscopic, resembled Zenker's necrosis, tended to be large and generalized, were present in nearly all of the animals, were elicited in about two weeks, were rapidly repaired after brief K administration, and thus differed considerably from E deficiency lesions. By contrast, cardiac muscle lesions, identical with those described by Follis, were unaffected by short periods of K therapy.

Matrix and cellular degenerative changes occurred in epiphyseal cartilages after the 16th day and became progressively more severe. These lesions differed from those induced by D, A, or C deficiency and from nonspecific changes associated with malnutrition, systemic disease or inanition. Additional studies are being carried out to clarify whether cartilage lesions arise as a result of K deficiency alone or in response to K therapy as administered.

The findings of new data during studies originally planned for another purpose precluded designing the reported experiments to answer all the questions raised. Concomitant lesions of heart, kidney and intestines previously described prove severe K deficiency was present. Differences in diets, differing proportions of dietary factors, the higher casein and sodium content of Cohen's diet, the short periods of K deficiency followed by brief K therapy are, as yet, of uncertain significance. The discord between the results of Cohen and Follis remains to be resolved.—J. GRUHN

The interrelationships between acetylcholine formation and the energy-providing glycolytic reactions intimately involve the potassium ion. In addition, the formation of acetylcholine may alter cell membrane permeability so as to enhance the rate of transmigration of potassium and other ions between intra- and extracellular compartments. The following paper should be read in its entirety for an understanding of the possible relationships of these concepts in the production of electrocardiographic deflections.

Studies on Permeability. VIII. Role of Acetylcholine Metabolism in the Genesis of the Electrocardiogram. W. C. Holland, C. E. Dunn, and M. E. Greig. *Am. J. Physiol.* 170: 339, 1952.

The work presented indicates a correlation between the height of the P, R, and T waves in the electrocardiogram and the rate of ion transfer of sodium and potassium into and out of heart muscle cells. These investigations support the thesis that the rate of ion transfer is controlled by the metabolism of acetylcholine. The suggestion is made that the production of the electrocardiogram may depend in part on the rate of production and breakdown of acetylcholine.—M. J. OPPENHEIMER

In diabetic acidosis, the electrocardiogram reveals changes which may reflect a depression of the intracellular potassium concentration. It is not felt that the ECG invariably reflects changes in the serum potassium concentration in this clinical state.

Potassium and the Cardiographic Changes in Diabetic Acidosis. C. B. Henderson. *Brit. Heart J.* 15: 87, 1953.

The following electrocardiographic abnormalities were observed among 10 cases of diabetic acidosis: arrhythmias (auricular fibrillation, nodal rhythm), tall and peaked P waves, widening and splintering of QRS complexes, depression of S-T segments, flattening and inversion of T waves, abnormally large U waves. Three cases exhibited a pattern hitherto undescribed in diabetic acidosis: high peaked T waves in the right chest leads and flat or inverted T waves in the left chest leads. Of 42 abnormal electrocardiograms taken, the degree of abnormality correlated in only 21 (50 per cent) with the level of potassium in the serum. The author suggests that in diabetic acidosis intracellular potassium concentration may be depressed, contributing to abnormal electrocardiographic patterns, in the presence of normal or even increased plasma potassium levels.—J. STAMLER

The blood potassium levels may be altered by the use of ACTH and certain steroid hormones. However, the ECG has not been altered in patients receiving these agents.

The Electrocardiogram and Potassium Metabolism during Administration of ACTH, Cortisone and Desoxycorticosterone Acetate. H. Ljunggren, R. Luft, and B. Sjogren. *Am. Heart J.* 45: 216, 1953.

Chronic administration of ACTH, cortisone, or desoxycorticosterone acetate to patients with rheumatoid arthritis effected a significant decrease in plasma potassium to hypokalemic levels, a negative potassium balance attributable chiefly to associated negative nitrogen balance, and only minor electrocardiographic changes not attributable to hypokalemia.—J. STAMLER

DIABETES

Clinical experience with diabetic patients indicates that the endogenous formation of insulin may initially be severely depressed, but that under good metabolic control some recovery of this function will occur. This is manifested by the gradually decreasing insulin requirements encountered in a significant number of diabetics. The factors involved in this apparent improvement are not clear. Possibly the carbohydrate-restricted diet permits some recovery of insulinogenic activity, just as the failing heart becomes compensated with restricted activity. This hypothesis is supported by the lack of abnormal morphological changes in the islet cells of many diabetics. In the following paper, this apparent clinical improvement has been ascribed to certain adjustments made in the patient's diet. However, others have noted the same phenomenon without altering the initial diabetic diet.

Carbohydrate and Fat Metabolism. G. E. Anderson, in Goldzieher, M., and Goldzieher, J.: *Endocrine Treatment in General Practice,* Springer Publishing Co., New York.

Diet Control. G. E. Anderson. Originally published and distributed by the New York Diabetes Association.

The Use of the Isocaloric Diet in the Management of Diabetes Mellitus. G. E. Anderson. *Brooklyn Hosp. J.* 10: 201, 1952.

Diabetes is the result of insulin insufficiency, either relative or absolute. There is a great fundamental and clinical difference between relative and absolute insufficiency. Clinical appraisal of the patient's response to therapy will usually identify which type of response to insulin is predominant without recourse to tests of insulin-sensitivity or glucose-insulin tolerance. The rationale of therapy depends on the predominant type of insufficiency. Intrinsic insulin function can be largely salvaged in most cases in which the deficiency is overwhelmingly relative. Anderson says the physiologic goal of therapy is the ultimate building up of the patient's own "intrinsic insulinogenic mechanism."

His concept of therapy is a practical application of the work of Himsworth, who showed that a low carbohydrate diet depresses the *normal* individual's sensitivity to insulin, and produces "hunger diabetes" glucose-tolerance curves; but on an isocaloric diet, as the quantity of carbohydrate is increased, there develops a progressive increase in sensitivity (responsiveness) to insulin with a concomitant favorable change in glucose-tolerance curves. Anderson duplicated these findings in *diabetic* patients provided they were first cleared of unrelenting hyperglycemia by the use of a mildly subcaloric diet. With adequate recovery periods in a previously relentless glycemia, short-lived postprandial hyperglycemia is permitted

to assume a normal physiologic function as a "trigger" mechanism to stimulation. At points above the 150-Gm. of carbohydrate per diem level with isocaloric diets there was, as the carbohydrate of the diet was increased, a decided stimulation of the "intrinsic insulinogenic mechanism" which could be measured by improvement in insulin-sensitivity tests, together with a progressive decrease in the individual's needs for extrinsic insulin. The *sine qua non* for the stimulating effect of carbohydrate is a religious initial adherence to a diet mildly subcaloric for the overweight patient or carefully balanced for the underweight. Insulin requirements are more a function of caloric than of absolute carbohydrate values of a diet. An initial basal level of 25 calories per Kg. at the patient's calculated normal weight is arbitrarily selected as a starting point in the dietary planning, but this is gradually increased as indications suggest.

For the practitioner, Anderson provides a convenient, flexible, easily mastered and workable system of isocaloric diet-prescription by means of a Diet Prescription Graph originally contained in the pamphlet "Diet Control," formerly available through the New York Diabetes Association, but now published as a revised booklet by Springer Publishing Co. of New York as an addendum to *Endocrine Treatment in General Practice* by Goldzieher and Goldzieher. Simple, flexible, easily followed dietary directions are provided for the patient in this pamphlet "Diet Prescription."

Anderson charges that therapy in diabetes mellitus has not kept pace with scientific advancement in the field of endocrine physiology, but has rested too completely in extrinsic insulin substitution rather than in rejuvenation of an impaired intrinsic mechanism. In the reviewer's opinion, Anderson's system of management moves toward closing this gap.—J. GRUHN

By gradually increasing the carbohydrate ration of their diabetic patients, the authors of the following report were able to achieve an intake of over 300 Gm. daily of carbohydrate, without significant changes in blood or urine sugar. These patients are stated to have been mild or medium severe diabetics, which makes this a rather remarkable achievement. Others have observed that mild and obese diabetic patients may achieve a significant degree of carbohydrate tolerance on caloric restriction. However, the recommendation of the authors for feeding 300 to 450 Gm. of carbohydrate daily is questioned.

High Carbohydrate, Low Calory Diet in Diabetes. A. Kaeding and H.-C. Moeller. *Deut. Zschr. Verdauungskr.* 12: 219, 1952.

In earlier studies with mild and moderate cases of diabetes, the authors found that a gradual tolerance to carbohydrate could be achieved. A relatively high carbohydrate (200–300 Gm.), low protein and fat diet was used, and it was found that the increased tolerance to carbohydrate which developed with this regimen lasted into the postexperimental period. In the present experiment, the authors sought to discover whether tolerance to carbohydrate could be still further increased.

Twenty-two cases of mild and moderately severe diabetes were studied; 11 patients received no insulin and the remaining 11 did. In all patients in the first group, the admission fasting blood sugar level, in most cases very high, was brought to within normal limits without insulin. Once normoglycemia and aglycosuria had been achieved, the brief initial period of low caloric diet was followed by a step-wise increase in carbohydrate, equally distributed over the entire day in five meals. Increasing the carbohydrate intake to over 300 Gm. (in 5 cases up to 400 Gm., in 1 to 430 Gm. daily) did not lead to any elevation of the fasting blood sugar. In the group receiving insulin, tolerance to carbohydrate was similarly increased, and it was not necessary—as had been reported earlier—to increase the dosage of insulin. Increased endogenous production of insulin is postulated to explain the fact that the gradual increase of carbohydrate did not increase the insulin requirement.

The authors emphasize the principle of caloric limitation in the treatment of diabetes mellitus, recommending the following regimen: 300–450 Gm. carbohydrate daily (average 340–380 Gm.); 40–50 Gm. fat; 70–100 Gm. protein.

It was found that patients whose diabetes had gone uncontrolled for long periods were harder to control than new cases and that increasing the dietary carbohydrates led to glycosuria more frequently in the former than in the latter. The authors see this as an additional reason for immediate clinical control of all new cases of diabetes mellitus.—C.-J. HOWELL

In the past, diets high in fat have been used in the treatment of diabetes. Some of these diets were unpalatable and, as we now believe, were unphysiologic. The modern diabetic diets provide a relatively normal intake of fat and carbohydrate. The latter substance, in normal dietary proportions, will augment the utilization of glucose in the tissues and will tend to increase endogenous insulin formation. The following paper provides an excellent orientation concerning the nutritional factors involved in diabetes.

Nutritional Problems Connected with Diabetes Mellitus. E. Geiger. *J. Am. Dietet. A.* 28: 905, 1952.

This review discusses nutritional problems in prevention and dietary management of diabetes. It is documented with a bibliography of 34 references.

The author presents evidence to substantiate his belief that in diabetes prevention, the deleterious effect of a high carbohydrate diet on the pancreas can be ruled out as a causative factor. The high caloric and fat content of the diet of Western civilizations may be at least conditioning factors responsible for increased incidence of diabetes. The lipotropic value and alkali-acid residues of diets have been

suggested as related to diabetes prevention. The author concludes this portion of his review with the following: "All these data seem to indicate that there is no single causative dietary factor and that besides the high caloric and fat content of the diets, other factors may be responsible for the high diabetes incidence in recent years or may at least facilitate the development of diabetes in hereditarily stigmatized persons."

It is not known whether factors which may prevent diabetes are identical with those which tend to correct it, but in therapy for diabetes the therapeutic goal is to restore or at least improve the utilization of glucose. It is a mistake to attempt to control this by severe dietary sugar restriction or by replacement with isodynamic quantities of other ingredients, such as fat. The problem is to correct decreased insulin production by dietary means. A further problem is to know how far dietary stimulation of the pancreas may be carried without further damage or exhaustion of the injured organ. Dietary composition may also affect sugar utilization and insulin sensitivity of the tissues. Diets rich in fat decrease, those high in carbohydrate increase insulin production and sensitivity. Previous sugar feeding increases utilization of glucose in the tissues. The effect of previous diet on the metabolic pattern of tissues may be explained in part by the extrapancreatic hormonal factors, e.g., a high fat diet prevents development of moon-face, acne, dizziness, and weakness which follow protracted ACTH treatment. The importance of protein in the diet of the diabetic is stressed and experimental evidence is reviewed for the differential effects of several fats and of fructose in diabetics.

The author warns against unrestricted free dieting in clinical diabetes and states in conclusion "at the present stage of our knowledge, nothing important can be added to the excellent dietary scheme developed by the American Diabetes Association, the American Dietetic Association, and the Diabetes Section, U. S. Public Health Service."—J. M. Smith

The search for sweetening agents which may be employed innocuously in the diabetic diet resulted in the following study involving honey. This substance was found to be tolerated well by mild and moderately severe diabetic patients. This is thought to be due to the high fructose content of honey. However, the use of this substance has not been generally advocated because of the finding by others of hyperglycemia following its use.

The Control of Diabetics during Honey Administration. V. Tobiasch and P. Kilian. *Deut. Zschr. Verdauungskr.* 13: 1, 1953.

Equivalent amounts of honey and glucose were given to healthy persons and diabetics. In healthy subjects, blood sugar values after honey rose somewhat faster and fell somewhat sooner than after glucose. The peaks reached after both (taking initial values as zero) were about equal after honey and glucose. In diabetics, there was a striking difference in the behavior of the blood sugar curves after honey and glucose, a difference far greater than could be explained by the margin of error inherent in the method. In single cases, in fact, the blood sugar rise after honey was only half that after glucose. Often the rise was faster after honey, and there was a more rapid decline in the curve. In 9 of the 17 cases, the blood sugar fell after 180 minutes to *below* the initial value. Among diabetics who regularly excreted a slight amount of sugar in the urine, there was generally no increase in glycosuria on "honey days." Often, in fact, there was a *decrease* in sugar excretion on these days. In no case was any lasting disturbance of carbohydrate metabolism (extending to the next day) observed after honey had been given.

After these preliminary experiments, it was decided to add small amounts of honey to the regime of diabetics, without otherwise altering the strictly dietary or insulin-aided control of the patients. Since it was difficult to ensure strict clinical control of the subjects, the authors offer no final opinion on this phase of their study. However, their short-term experiments indicate that small amounts of honey in the diabetic diet are well tolerated. The addition of 20 Gm. of honey in the morning and 20 Gm. in the afternoon had practically no influence on the blood sugar curve (the peak was no higher than that reached without honey). In other diabetics, 20 Gm. of honey every second day did not disturb the control previously achieved. (This amount of honey would, of course, supply no more than 60 to 120 calories.)

One important point is made: pure summer honey is much better tolerated than winter honey (from bees fed cane sugar). Winter honey produced a much higher elevation of the blood sugar level than summer honey, though in neither case was the contrast as striking as that between the rises following honey and sugar. Nor were the differences so constant.

These short-term experiments require confirmation by long-term studies, but they seem to show that pure summer honey in small amounts (10–20 Gm./day) does not interfere with carbohydrate metabolism in controlled cases of mild and medium severe diabetes.—C.-J. Howell

The metabolism of mannitol and sorbitol have also been studied with reference to their possible use as sugar substitutes.

The Metabolism of Mannitol and Sorbitol. Their Use as Sugar Substitutes in Diabetic Therapy. W. H. Olmsted. *Diabetes* 2: 132, 1953.

Conflicting evidence concerning the metabolism of sorbitol and of mannitol (congeners of glucose) in non-diabetic man and animals is catalogued and reviewed. Olmsted inclines toward the view, based in

part upon results of C^{14} tracer studies in diabetic rats, that sorbitol would augment insulin requirement of diabetic patients but to a lesser degree than equivalent quantities of glucose, since the latter appears to be more rapidly absorbed. Mannitol appears to be only slightly, if at all, utilized by man but appears to be definitely utilized to a small extent by certain animals, especially the rat. Nevertheless, the cathartic action of appreciable increments of mannitol taken by mouth appears to preclude its use as a sweetener. Although sorbitol appears to have a lesser laxative effect, it is stated to be substantially less sweet-tasting than such agents as saccharine. The precise role of sorbitol as a sweetening agent in the diet of diabetics awaits further definition. For those physicians who permit diabetics rather liberal and somewhat variable intakes of carbohydrate, in relation to previous habit and desire of the patient, search for an ideal non-utilized substitute for sucrose is an academic problem.—R. TARAIL

Various substances have been found to protect experimental animals from diabetes induced by alloxan. Among these are mannose and fructose.

Protection Against Alloxan Diabetes by Mannose and Fructose. G. Bhattacharya. *Science* 117: 230, 1953.

Mannose and fructose, given prior to the injection of diabetogenic doses of alloxan, prevented diabetes in rats. The relative abilities of the hexoses to protect against alloxan diabetes are directly comparable to their effectiveness in alleviating hypoglycemia in animals and to their affinities for hexokinase. The author suggests that the protection afforded may be due to a protection of the hexokinase in the beta-cells of the islets against alloxan poisoning.—S. O. WAIFE

The quest for pathogenetic factors involved in diabetes mellitus has been furthered by the development of a strain of obese mice with diabetes. These animals provide a tool for the study of metabolism in obesity and diabetes.

Familial Diabetes Mellitus in Mice, Associated with Insulin Resistance, Obesity, and Hyperplasia of the Islands of Langerhans. V. R. Bleisch, J. Mayer, and M. M. Dickie. *Am. J. Path.* 28: 369, 1952.

The authors describe a strain of obese mice with constantly associated diabetes and insulin resistance. The obesity is inherited as a simple Mendelian recessive. These animals have islands of Langerhans which are larger and more numerous than normal. They show less than normal amounts of hepatic glycogen. This group was compared to the siblings which were non-obese, insulin-sensitive, and had large amounts of liver glycogen and only moderate increases of pancreatic island size. "The association of insulin-resistance with marked island hypertrophy in the obese mice suggests a growth stimulus associated with insulin-resistance." The hyperglycemia and lability of blood-sugar levels of the obese were quite different from the stability of blood sugars in the non-obese siblings. According to one theory of the regulation of appetite, the metabolic defect of the obese animals was such that they stored less liver glycogen and were less able to maintain stable blood glucose levels and, as a result, had greater appetites.—S. O. WAIFE

In contrast to the previous study of enlarged pancreatic islets is the following observation on the effect of undernutrition on this tissue.

Effect of Chronic Caloric Insufficiency on the Growth of the Islets of Langerhans. M. A. Ashworth, N. C. Kerbel, and R. E. Haist. *Am. J. Physiol.* 171: 25, 1952.

Rats of 50 Gm. weight were kept on a restricted amount of calories so that their body weight remained constant. The weights of the islets of Langerhans of the test group were less than those of the control group at the end of the period. Less food was needed to maintain body weight as the time of restricted caloric intake was prolonged. Islet tissue weight and total body weight are closely correlated. Pancreas weight increased although body weight remained constant. The authors conclude that the islets are prevented from growing when calories are restricted to maintain a constant body weight—M. J. OPPENHEIMER

Diabetic coma and lipodystrophy are two "complications" of diabetes on the opposite ends of the therapeutic spectrum. The following papers discuss recent French experience with these important matters.

Studies on Ketosis and Diabetic Keto-acidosis. Reflections on Two Cases of "Diabetic Coma." E. Azerad, H. Lestradet, and D. Alagille. *Presse méd.* 60: 1702, 1952.

After having recalled the necessity of a correct terminology in the classification of the states of ketosis in diabetics, the authors report two observations of serious diabetic keto-acidosis, authenticated by a very significant lowering of blood pH, the presence of severe ketonemia, elevated glycemia, and a more or less profound alteration of consciousness.

From the therapeutic standpoint, the correction of the acidosis—that is, the return to a normal blood pH—is a primary step in treatment, since this normalization may of itself restore enzyme and insulin activity, improve tissue and brain cell metabolism, and correct—at least in part—the vascular disturbances, all this being evidenced in an amelioration or even an apparent clinical cure.

The doses of insulin should be adapted to each particular case. The administration of glucose should not be undertaken until the action of the insulin becomes apparent; that is, when the glycemia is

obviously decreasing. Hypocalcemia needs to be investigated and systematically corrected. Rehydration, which constitutes an essential phase in the treatment, should be adapted as rigorously as possible to the needs of the organism.—H. GOUNELLE

Study of 14 Cases of Insulin Lipodystrophy. R. Boulin, H. Chimenes, and R. Tourneur. *Presse méd.* 60: 1024, 1952.

Lipodystrophies, atrophies, and hypertrophies are local accidents of insulin therapy. They are found in 2 to 6 per cent of insulin-treated diabetics. More than nine-tenths of these cases are observed in women. Their clinical importance depends above all on the fact that insulin lipodystrophies are a major cause of false insulin-resistance and false instability. Their pathogenesis is far from clear. One may assume the intervention, on the one hand, of the hormonal factor, which may exercise a determining influence, and, on the other, of a certain tissue intolerance to insulin; this intolerance has as its consequence direct or indirect lesions of the adipose cells.

In their cases the authors have obtained an excellent equilibrium in diabetes with doses of insulin notably smaller than before treatment—first, by injecting the drug in such a way that a zone of 1.2 cm. receives no more than a single inoculation per month, and secondly, by injecting each week from 40 to 100 mg. of male sex hormone. They observed a regression of the lesions on this regimen.—H. GOUNELLE

IRON METABOLISM

The rate of assimilation of iron from ingested food sources depends upon a variety of factors, such as the availability of this mineral substance in its chemical combined form and the metabolic requirement for iron during a given period. The mechanism for iron absorption in the gastrointestinal tract appears to involve a protein-iron union within the mucosal cells, so that the rate of iron uptake from food is thought to be dependent upon tissue needs. Some of these concepts may be altered by the following type of study, in which radioactive iron has been incorporated into food, thus making possible the study of iron absorption in man.

Absorption of Radioiron from Foods. C. V. Moore and R. Dubach. *Science* 116: 527, 1952.

The assimilation of iron from foods has been an important and only partially solved problem. The daily requirement for iron cannot be established with certainty until the completeness of iron absorption is known. By growing or producing common foods such as eggs, chicken liver, chicken muscle, and spinach containing radioiron (Fe^{59}) it has been possible to study iron absorption in man.

Healthy human subjects absorbed less than 10 per cent of the radioiron. Iron-deficient subjects usually did not assimilate iron in food more efficiently than normal persons. However, ascorbic acid, or foods containing it, enhanced the absorption of iron in food.

It was also found that the administration of hydrochloric acid did not increase the absorption of Fe^{59} in patients with achlorhydria.

The authors estimate that the normal male adult must assimilate from 0.5 to 1 mg. of iron a day to maintain normal iron stores. The normal woman needs about 1.0 to 1.5 mg. a day, depending on menstrual loss. Since only 10 per cent of food iron is absorbed, the recommended dietary allowance of 12 to 15 mg. a day is not excessive.—S. O. WAIFE

The role of copper in the metabolism of iron, and particularly in the formation of hemoglobin, has received considerable attention. In certain animals and in human infants, copper deficiency is thought to be responsible for an iron-deficiency type of anemia. Copper deficiency in swine results in a microcytic hypochromic anemia with a reduction of plasma iron values.

Studies on Copper Metabolism. II. Hematologic Manifestations of Copper Deficiency in Swine. M. E. Lahey, C. J. Gubler, M. S. Chase, G. E. Cartwright, and M. M. Wintrobe. *Blood* 7: 1053, 1952.

The effects of a deficiency of copper and iron, singly or together, were compared in a total of 70 swine. The animals deficient in copper developed deformity in the contour of the legs with the result that the animals became short and squatty. Anemia, which was microcytic and hypochromic, occurred rapidly after the first month; the hemoglobin decreased from 15 to 2 Gm. in about 40 days. The bone marrow was normoblastic, there was a very mild leukopenia, and platelets were normal. The plasma copper fell rapidly, erythrocyte copper more slowly. Plasma iron decreased rapidly even though these animals received 30 mg. iron/Kg. of body weight per day. The iron-binding capacity of the serum rose. Erythrocyte protoporphyrin, serum proteins, serum bilirubin, erythrocyte fragility, and urinary tyrosyl derivatives after the administration of tyrosine were not changed significantly. The iron-deficient animals showed essentially the same morphologic picture as those which were copper-deficient, except that the former group had no leukopenia and frequently thrombocytosis. Copper-deficient animals responded rapidly to copper and all hematologic and chemical values became normal. Copper- and iron-deficient animals, in which the changes noted above had occurred more rapidly than in the group deficient in copper alone, showed no response to iron alone; copper alone induced an increase in plasma copper and reticulocytosis but no other hematologic change. Copper and iron concurrently induced a complete hematologic response. These results suggest that in copper-deficient swine there is an abnormality in the

metabolism of iron, and that the microcytic hypochromic anemia may occur because of this abnormality.—R. W. VILTER

Copper deficiency apparently will decrease the rate of absorption of ingested iron and will also reduce the utilization of endogenous iron. This is a further demonstration of the essential interrelationship of these two minerals in human physiology.

Studies on Copper Metabolism. III. The Metabolism of Iron in Copper Deficient Swine. C. J. Gubler, M. E. Lahey, M. S. Chase, G. E. Cartwright, and M. M. Wintrobe. *Blood* 7: 1075, 1952.

This paper, following in natural sequence the preceding one, demonstrates that iron is poorly absorbed from the gastroenteric tract of copper-deficient pigs. The total iron of blood, liver, kidney, spleen and heart of copper-deficient pigs was 13.6 mg./Kg. body weight; compared to 13.1 mg./Kg. body weight in iron-deficient pigs, and 50.5 mg./Kg. body weight in control pigs. Fe^{59} given orally was recovered to an extent of 1.8 to 1.9 per cent from these same organs as compared with 6.1 per cent in control animals. Copper- and iron-deficient pigs failed to respond to iron or copper alone and the plasma iron levels did not increase until copper was given.

Copper was essential for the utilization of iron in the formation of hemoglobin also. Parenterally administered iron was not utilized for the formation of hemoglobin as indicated by lack of hematopoietic response and failure of incorporation of Fe^{59} into hemoglobin.

Mobilization of iron from tissue stores was also impaired in copper-deficient animals. Though tissue stores were decreased only slightly, movement of iron from tissues into plasma was decreased until copper was given.

These very important data suggest that copper is essential wherever iron moves, i.e., past the mucosal cell of the intestine, into or out of tissue stores, and into the hemoglobin of the erythrocyte. The chemical mechanism responsible for this effect is unknown. —R. W. VILTER

In iron-deficiency anemia, there is a reduction in total body iron. This is reflected not only in plasma iron levels, but also in the protein-bound storage forms of iron.

Investigations of Ferritin in the Bone Marrow in Severe Iron Deficiency. M. Taubert and L. Hoffmann. *Ärzt. Forschung* 6: 505, 1952.

Although the estimation of serum iron level has proved clinically important, our knowledge of the significance of tissue, or storage, iron is still too slight to make its determination a useful clinical procedure. However, a better understanding of iron metabolism, and particularly of the three forms of protein-bound storage iron (hemosiderin, ferritin, and ferrin) will probably show important reciprocal relations between serum and tissue iron and force clinical attention to the latter.

The authors report their investigations of the bone marrow of a patient with severe hypochromic anemia. Before treatment, when the iron deficiency was most severe, they were unable to obtain any ferritin from 0.2 Gm. of blood-free sternal marrow. After intensive oral iron therapy, when the blood picture had returned to normal, the marrow was again investigated, and this time the presence of ferritin was clearly demonstrated. The authors make the tentative suggestion that, in addition to a lowered level of serum iron, there is a reduction or complete absence of ferritin in the marrow in severe iron deficiency.

It should be noted that the single case considered here was not an ideal one for the study of iron deficiency, as the patient had been a blood donor and his depleted condition was the result of excessive blood loss, rather than the reflection of any "idiopathic" failure of iron absorption. Whether the findings reported here would be the same in chronic hypochromic anemia remains to be demonstrated.—C.-J. HOWELL

According to present concepts, based upon extensive studies dealing with iron excretion, this mineral is not normally thought to be excreted or lost from the body by any route except that of blood loss or by way of desquamation of cells. However, in the following paper it has been found that alterations in the serum iron level are associated with changes in renal iron excretion.

Studies in Iron Metabolism. 2. Renal Iron Excretion in Various Diseases. A. Morczek. *Deut. Zschr. Verdauungskr.* 12: 14, 1952.

Following earlier studies of the urinary excretion of iron in normal subjects, the author here considers iron excretion in various pathologic conditions.

Elevation (transient or prolonged) of the serum iron level was accompanied by increased renal iron excretion in a whole series of illnesses. In pernicious anemia, urinary iron excretion was moderately increased; it was still higher in hemolytic icterus; and extremely high values (up to 10 mg. of iron daily) were found in hemochromatosis.

No important deviations from normal urinary iron values were observed in the various infectious diseases. It is therefore clear that the low levels of serum iron and resultant anemia which are found in chronic infections are not due to any excessive renal iron loss. Iron deficiency conditions found after hemorrhages or with neoplasms do not result in any decrease in renal iron excretion.

Noting that a rise in serum iron level (whether due to oral iron administration or pathological changes) is associated with increased renal iron excretion, the author believes the kidneys play a contributory role

in the regulation of iron metabolism, acting to counteract an excessive rise of the serum iron level.—C.-J. Howell

Parenteral iron therapy has not received wide recommendation because of the toxicity which may be associated with elevated blood and tissue levels of this substance. In fact, the over-zealous administration of parenteral iron may be fatal. However, there are occasions when the administration of iron by parenteral injection is indicated, such as in iron-deficiency anemia associated with prolonged anorexia, nausea, and vomiting.

Retention of Intravenously Injected Iron in the Organism. W. Lintzel. *Ärzt. Forschung* 7: 134, 1953.

The small amount of iron which is absorbed from the daily diet, and the lethargic rate at which the body builds and replenishes tissue iron stores has made the rapid restoration of depleted storage iron a problem.

In young cats, the author tested the efficacy of the intravenous route in the correction of iron deficiency. Iron was injected in the form of Ferri-Amphiolen (Merck). Single doses of 0.1 to 0.6 mg. Fe—in some cases of 4 mg. Fe—were repeated three times at intervals of 1 to 2 days. In a man weighing 70 Kg., the equivalent amounts would be 16 to 115 mg. Fe, and, in the extreme cases, 470 mg. Fe. Two to three days after the last injection almost all of the injected iron was found in the liver. After administration of amounts of iron greatly in excess of the therapeutic dosage, a certain amount of iron was detected in the lungs, and, in some cases, small amounts were found in the spleen. In no case did iron appear in the kidneys.

The indications are that the intravenous route is both rapid and effective in replenishing exhausted iron stores.—C.-J. Howell

Clinical Trial of Intramuscular Ferric Phosphate in a Case of Iron Deficiency: A New Method of Assessing Iron Absorption. A. Goldberg and H. E. Hutchison. *Glasgow M. J.* 34: 35, 1953.

This report of a clinical trial with intramuscular ferric phosphate confirms the negative conclusions of others as to the value of iron administration by the intramuscular or subcutaneous route. The difficulties of intravenous iron administration make a suitable preparation for the simpler parenteral methods a clinical desideratum, but apparently no such preparation has been developed.

Daily intramuscular injections of 100 mg. of ferric phosphate were given over a period of 10 days to a young man with "idiopathic" chronic hypochromic anemia and achlorhydria. There was pain at the sites of the injections; the patient developed a fever; and blood and marrow examinations showed no significant improvement by the thirteenth day after initiation of treatment.

With intravenous saccharated iron, the results were far different; there was a rapid and sustained rise in hemoglobin (by the thirtieth day it had doubled), and sternal marrow examination showed a normal amount of stainable iron on the forty-ninth day after initiation of intravenous therapy.

Since the dosage of ferric phosphate and the trial period were both more than adequate, and since iron reaching the bone marrow is known to be used for hemoglobin regeneration within only a few hours, lack of hemoglobin response indicates that the intramuscular preparation was either not absorbed, or, if it was absorbed, was stored and not available for hemoglobination.

The authors recommend that in further tests with intramuscular iron preparations the subjects be selected carefully; that is, they should be confined to those cases of chronic hypochromic anemia in which the only impediment to hemoglobin regeneration is the absence of sufficient labile iron, and which are not complicated by the loss of indeterminable amounts of blood, infection, neoplasm, or previous malnutrition. Repeated pretrial studies of the blood picture, and "before and after" investigations of the sternal marrow for hemosiderin should be made. If intramuscular therapy proves ineffective, the subject's capacity to respond should be further tested by a control course with a proved parenteral preparation, such as saccharated iron oxide.—C.-J. Howell

That all is not clear in the clinical aspects of iron deficiencies is illustrated by studies of the relation of the liver to serum iron and nutritional aspects of the hypochromic anemia of infancy.

Serum Iron in Liver Disease. H. Ducci, A. Spoerer, and R. Katz. *Gastroenterology* 22: 52, 1952.

The mean value of serum iron obtained in 40 normal subjects was 108.4–4.05 μg. per 100 cc., with no significant difference between the sexes. When the results of the first examination of serum iron in each of 62 cases of acute hepatitis, 68 cases of cirrhosis of the liver, and 27 cases of posthepatic jaundice were compared with these values, there was a clear tendency toward higher values in hepatitis. In an appreciable number of patients with posthepatic jaundice the first determination of serum iron gave values in excess of 200 μg. per 100 cc., but in no case did the values exceed 300 μg. per cent as was true in some cases of hepatitis. There was a lack of a strict correlation between serum bilirubin and serum iron in all 3 groups of hepatobiliary disease.—J. E. Berk

Iron Metabolism and the Hypochromic Anemia of Infancy. H. W. Josephs. *Medicine* 32: 125, 1953.

In this long and complete review (388 references) of iron metabolism, the author considers the dietary

factors which influence iron absorption in general and iron deficiency anemias in particular.

The part played by milk in iron deficiency is not clear. The iron in milk is well absorbed and, according to radioactive iron studies, of the common foods, milk interferes least with iron absorption. There is some evidence that the total protein intake may be an associated factor. According to Josephs, the evidence for the interrelation of ascorbic acid and vitamin B complex with iron in clinical anemias is not convincing. Perhaps the most important of the interrelated causes of a hypochromic anemia in infancy is the rapid rate of growth in this age group. There appears to be a limit to the rate at which iron becomes available for hemoglobin formation, resulting in a reduction in color index and serum iron levels. Examples may be found during the treatment of pernicious anemia, scurvy, certain infections, etc. Not only are infants replacing the normal blood destruction, they are also increasing the total red cell mass as part of their growth. The more difficult question is, why do not more infants develop anemia? —S. O. WAIFE

BODY COMPOSITION

Studies of mammalian metabolism have been advanced by the division of the organism into various compartments, such as lean body mass, body fat, and water. The establishment of normal criteria for these compartments at various age levels of the human and the effect of disease upon them will have great significance. The estimation of total body fat may be accomplished in several ways, one of which involves the measurement of the uptake of a fat-soluble gas.

Measurement of Total Body Fat in Living Rats by Absorption of Cyclopropane. G. T. Lesser, A. G. Blumberg, and J. M. Stelle. *Am. J. Physiol.* 169: 545, 1952.

Rats were placed in a closed system and the amount of cyclopropane taken up was used as a measure of the body fat content. Values thus obtained agree closely with the weight of total ether extractable material. By both methods the average fat content was 13.2 per cent plus or minus 0.7 per cent. Cyclopropane is highly soluble in fat and errors from estimation of amounts of cyclopropane in lungs, intestinal gas and non-lipid tissues produce only small errors in body fat determinations. The ratio for cyclopropane in fat:non-lipid tissues (water solubility) is 52:1 as compared to nitrogen where it is 5:1 approximately. In practice, the effect of proteins reduces this favorable ratio to 26:1 approximately. When equilibrium for cyclopropane is established approximately 90 per cent of all the cyclopropane in the body is present in fat.—M. J. OPPENHEIMER

Any picture of total body composition must consider body water and electrolytes. This is not a simple matter at all, but, as the following paper shows, some progress is being made.

Body Composition: Studies in Human Being by the Dilution Principle. I. S. Edelman, J. M. Olney, A. H. James, L. Brooks, and F. D. Moore. *Science* 115: 447, 1952.

This is a review of the history, general principles, and recent advances in the study of the composition of the human body by means of the dilution of various substances, some of which may be traced by radioactive tracer techniques. According to the authors, there is no perfect plasma volume determination technique. For example, since there are large amounts of albumin outside the plasma in the lymph of liver and viscera, any valid albumin tracer will equilibrate into these areas outside the plasma. Radioactive iron-tagged red cell methods seem to be the best. Other isotopic red cell tags (P^{32}, Cr^{51}) show variable rates of leakage of the tags because they are held in the cell by a binding less stable than that of iron and hemoglobin. Furthermore, there are truly more red cells per unit of blood in large vessels than in the body as a whole. Normal blood volume varies from 7 to 9 per cent of body weight in healthy young adult males and from 6 to 8 per cent in young adult females.

All the methods for the measurement of extracellular fluid involve technical difficulties and interpretive uncertainties, because no substance has yet been identified that is a small molecule readily diffusible into all extracellular areas, non-metabolized, and exclusively extracellular in distribution.

Deuterium has been used to measure total body water. It appears that when plasma volume and transcellular water (the latter term being extracellular water and fluid in the cerebral spinal fluid, gastrointestinal tract, bile, etc.) are subtracted, the interstitial fluid forms 12–15 per cent of body weight.

The total body water in normal males is 62 per cent of body weight and in the female 51.5 per cent. This includes plasma water, red cell water, interstitial water, all the varieties of lymph, all the intracellular and transcellular water.

Measurements of sodium and potassium ordinarily do not include areas of slow or incomplete exchange (for example red cells for potassium; bone for sodium). Therefore, using total exchangeable sodium and potassium measurements, it appears that the mean exchangeable sodium in young adult males is 41.4 mEq/Kg.; in females 41.0. The mean exchangeable potassium in young adult males is 46.8 mEq/Kg.; in females 40.7.

Interesting data relative to rates of exchange and metabolic correlations with total body fat are also included in this paper. The metabolic response to surgery is characterized chiefly by oxidation of fat, degradation of protein, loss of potassium, transfer of sodium into cell, and a tendency to increase body water.—S. O. WAIFE

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